RADIO

ESTABLISHED 1917

Design, Research
Production, Operation

★

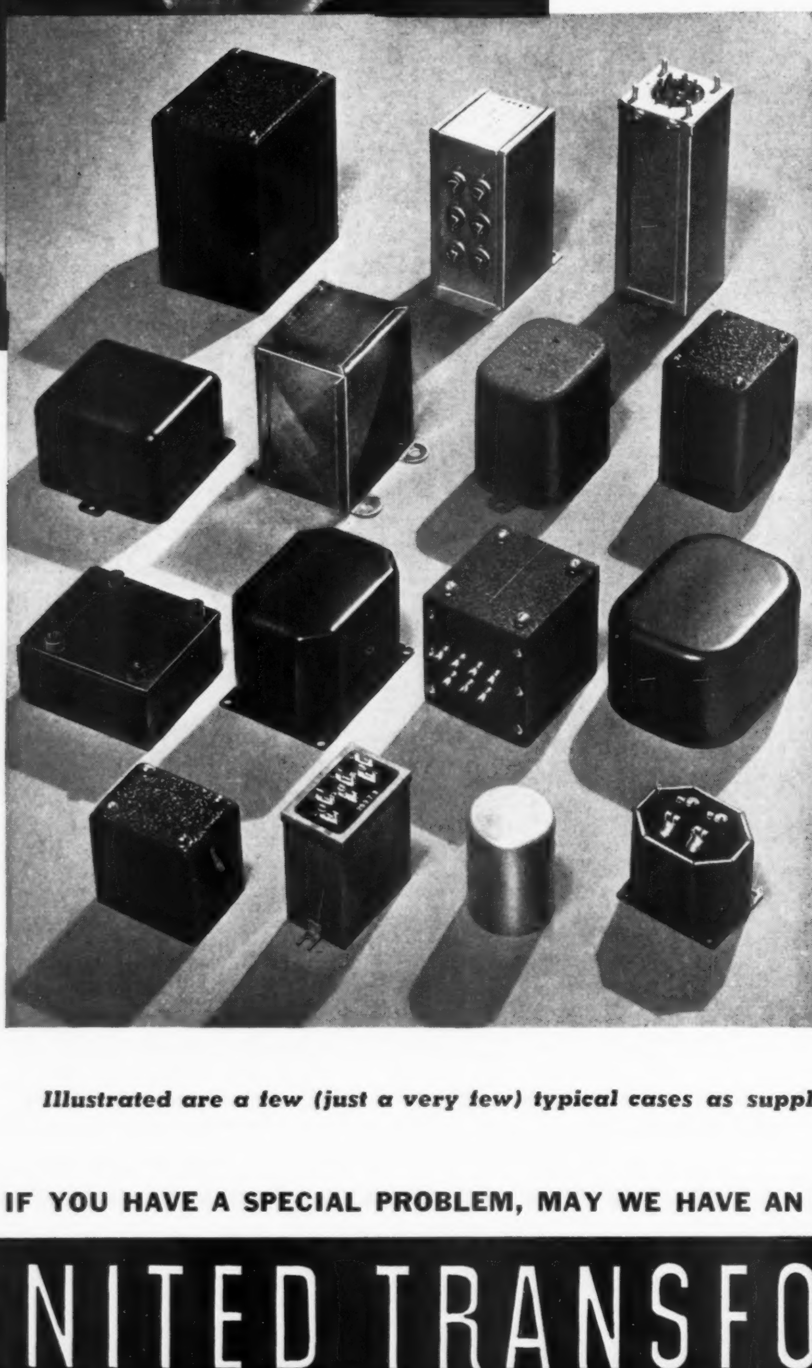
September, 1942

NUMBER 272

35c IN U.S.A.

TOUGH?

Not when YOU'RE EQUIPPE[D] TO HANDLE THE[M]



In addition to the electrical chara- teristics, many customers' applicati- problems are related to the physic- appearance and dimensions of th- transformer components. Fortunat- ly, the UTC sheet metal division su- plies practically all the housin- laminations, brackets, and other d- vices which control the mechanic- characteristics of UTC units. Inste- of restricting designs to specific cas- the sheet metal division can run of- special case to more closely fit t- final transformer dimensions, or t- effect the particular mounting pro- sions required by the application.

The sheet metal division h- drawing, forming, and other pre- facilities to cover the enti- gamut of transformer housin- from tiny transformer chann- to large oil tanks for broa- cast and industrial service. Si- these housings are produced - UTC, fast service can be giv-

Illustrated are a few (just a very few) typical cases as supplied for some special applications

IF YOU HAVE A SPECIAL PROBLEM, MAY WE HAVE AN OPPORTUNITY TO COOPERATE?

UNITED TRANSFORMER CO

150 VARICK STREET ★ NEW YORK, N.

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Now! FOR THE First Time
YOU CAN ENLIST IN THE
U. S. ARMY SIGNAL CORPS!
... restrictions have been cut to a minimum. If you are eighteen to nineteen and physically fit, you can enlist directly into the U. S. Army Signal Corps ... if you are nineteen to forty-five and can pass the physical examinations, you can enlist providing you have some experience in the Communications Industry and have not received your notice for induction.
the hallicrafters co.
CHICAGO, U. S. A
Keep Communications Open

EDITORIAL

RADIO AND ELECTRONICS

Definitions, like the four freedoms, cannot be established without effort. Both words and freedoms can be tampered with or loosely applied.

There is now some question as to the proper definitions of the words Radio and Electronics; and differences of opinion as to whether or not they are synonymous. As obvious as the answer is, it presumably needs clarification in some quarters.

The word Electronics was coined by the McGraw-Hill Publishing Company as the name for a so-called "horizontal" magazine to straddle the whole field built up around the electron tube. By virtue of the ever-increasing number of applications for the electron tube and the undisputed fact that the name is a "natural," Electronics has become a generic term. If it is to be correctly defined, then it covers, among other things, the field of Radio; but, by the same token, is not synonymous to it; for Radio is but one branch of the Electronic field.

There is a tendency on the part of many radio publishers to hop aboard the electronics bandwagon, either by instituting new "horizontal" papers in this field, or changing "vertical" papers to cover the broader field. Whether or not there is room for all of them, we do not profess to know. We do know, however, that were all radio magazines to follow suit, the division of attention or scattering of effort would work a hardship on the thousands of engineers, technicians and operators who deal almost exclusively with radio frequencies and seldom if ever deal with any other phase of electronics.

Radio, as a branch of electronics, is a large field in itself, and will be larger still after the war. It is entitled to a magazine devoted exclusively to its interests, now and hereafter. RADIO magazine will stick to those interests through hell and high water.

THE ENGINEER AND PETRILLO

One of the latest of a string of orders issued by James C. Petrillo, president of the American Federation of Musicians, forbids members to take part in the making of one-shot transcriptions for broadcast stations. This edict is a minor annoyance or a major catastrophe, depending upon which side of the fence one is on; but, in any event, it poses a nice problem for engineers who contribute in one manner or another to technological progress, and feel, along with Mr. Van Dyke, that the engineer should have some voice in sociological matters.

We said, in an editorial in the August issue, that should the engineer make the mistake of thinking that life can be arranged to fit a plan derived from an ideal, then the reality of life as contradistinguished from the reality of pure truth will have escaped him, and the effort to improve society will have been in vain. Mr. Petrillo's ban on electrical transcriptions is a perfect example of the oil-and-water characteristics of idealistic planning and life as she is lived.

It is an interesting commentary on modern life that something the engineer conceived and developed may now not be used by him or for him. It is also sad; and more than likely a warning of similar conflicts between technological progress and the professions or crafts such progress appears to endanger. The Petrillos of this world do not react to truths or logic, and more than likely can be "convinced" by nothing less than the counterforce of an engineering power group in the form of a guild. As displeasing as such a setup may sound to engineers who never wish to do anything more than mind their own business, a union of technologists seems to be the only answer.

We do not have to be told that the backlog of wartime inventions will alter the shape of our future society; nor do we have to have it impressed upon us that progress in all technological fields will tend to snuff out many crafts. Somehow, in some manner, men who have spent their lives in developing proficiency in a given trade will have to be reconditioned and placed elsewhere, and this cannot be done entirely by planning. The engineer will have to make his voice heard and his power felt; else there will be a peck of trouble, and our technological gains will sour the world.

We hold with Mr. Van Dyke that something should be done. Discussions should take place now, before the wartime backlog of developments is released.

M.L.M.

RADIO

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SEPTEMBER 1942 No. 272

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COVER

Angle shot of protective gaps on KMPC's new 10,000-watt directional antenna array located in north Hollywood, California. Photographed by F. H. Ragsdale, KMPC Technician.

ARTICLES

MISCELLANEOUS

Broadcast Station

MAINTENANCE and OPERATION

C. H. WESSER
Chief Engineer, W45D

PART I

Now, more than ever before in the history of broadcasting, it has become imperative that all broadcast station equipment be operated and maintained at peak performance, and at its greatest possible efficiency. The problems involved are aggravated in many cases by the fact that some of the older and more experienced engineers have left their berths with broadcast stations, and are now taking part in the war effort in the employ of manufacturing organizations and the armed forces. Added to this is an increasing scarcity of tubes and other necessary replacement parts, with little or no prospect of relief in sight. As a result of these factors and conditions, the average broadcast engineer is more "on his own" now than ever before, and his station's as well as his own survival depend frequently upon his ingenuity and originality in devising ways and means of maintaining his equipment in top-notch condition, yet maintaining the high standards of performance that have made broadcasting one of the nation's most important and necessary public services.

Station Routines

Since only closely-adhered-to routines, and the keeping of accurate records will make for top efficiency, this paper presents ideas and suggestions in the form of a description of such routines. The establishing of, and adhering thereto will materially ease the task of the broadcast engineer in the operation and maintenance of his equipment.

Rather than using a hypothetical case, the operation and maintenance routines of F.M. Station W45D are used as an example, but not necessarily as an absolute standard, although they have shown over a period of more than a year that they cover regular operation very thoroughly, and have provided good guidance for all members of the station's Technical Department. They have made possible a good record of performance in spite of the fact that practically all of the station equipment was new to every member of the staff. Very little if any precedent existed for the staff's guidance, since 50-kw F.M. transmitters are few and far between and have been in existance for only two or three years. W45D, operating on a commercial basis, is treated exactly as an A.M. station as far as operating and maintenance routines are concerned. Therefore, W45D's routines would be applicable to any A.M. broadcast station.

Operating Schedules

The routines presented are based on the following operating schedule:

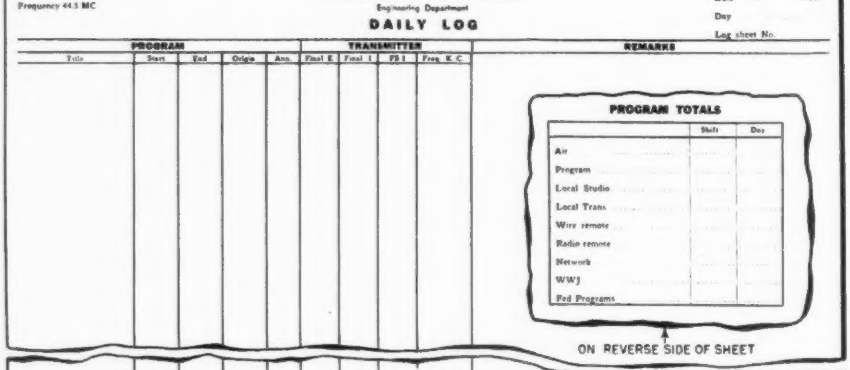
Weekdays:

Air time .... 5:00 AM-12:00 MN
Program time .... 6:00 AM-12:00 MN

Sundays:

Air time .... 7:00 AM-12:00 MN
Program time .... 8:00 AM-12:00 MN

This schedule is pretty much representative of that of most broadcast stations, providing for 124 program hours and 16 warm-up and maintenance hours per week. The members of the staff are full-time employees working 40 hours weekly, and no part-time help is considered. Each man works six days per week, although with slight modifications, and possibly an extra man, a 40-hour, 5-day week could be handled in much the same manner. The schedule provides for two men on both the opening and sign-off shifts, with the Chief Engineer available to fill in and provide extra help when and where needed (see "Engineers Schedule" chart). Shifts are assigned with due consideration of the individual's preferences whenever possible, but the main shifts rotate every eight weeks. A Remote Engineer is provided and is expected to perform certain station maintenance and operational duties when not engaged in remote work or maintenance of the remote equipment for which he is solely responsible.



The daily log sheet used by the engineering department at W45D. Data with regard to program totals appears on the reverse side of the log sheet. The routine is described in the accompanying text.

ENGINEERS' SCHEDULE

	(1)	(2)	(3)	C.E.	(4)	(5)	(6)	(7)
Sun.	A	D	B	X	X	F	C	R
Mon.	A	D	B	E	C	X	F	R
Tue.	A	D	B	E	C	F	X	R
Wed.	X	D	B	E	C	F	A	R
Thu.	A	X	B	E	C	F	D	R
Fri.	A	D	B	E	C	F	R	X
Sat.	A	D	X	E	C	F	B	R

Shifts run as follows:

"A"— 5:00 AM—11:40 AM
"D"— 5:00 AM—11:40 AM
"B"—11:40 AM— 6:20 PM
"E"—When available and needed
"C"— 6:20 PM— 1:00 AM
"F"— 6:20 PM— 1:00 AM
"R"—Remotes, 6:40 hours daily, when needed
"X"—Indicates off-day

The reader's reference to the article on W45D in the June, 1942, issue of RADIO may aid materially in following the routines described, in relation to the physical layout of the station, and the consideration of the layout in the development of the work schedule.

Shift Routines

Following is the complete set of all shift routines, prescribing, step by step, the work to be performed by each man. Each item of work is numbered and on the accompanying routine check sheet *(Fig. 1)* these item numbers appear under the heading of each shift. The man who performs the various items checks them off when completed. This check sheet guards against the failure to complete any routine duty. If for some reason a certain item is not completed, the engineer whose duty it was to perform it notifies his relief who completes it as soon as possible. The division of work between the two men on any one shift is done on the assumption that one is Transmitter Engineer and the other Main Control Room (MCR) Engineer. Actually this division is not closely adhered to because it is important that every man be familiar with the work of his shift-mate, since it is considered bad policy to develop an "indispensable man" on any shift. Preventing that evil makes shifting of men and replacement because of war activities much easier, although it may be impossible to train and develop more than one particular man for administrative work. Generally this work is handled by the Chief Engineer because he is usually the man best acquainted with the organization's practices and policies, and is therefore best suited to perform those duties most efficiently.

The system of numbering items of work in the order in which they are to be performed, and the use of a check sheet, make it comparatively easy to break in a new man who is totally unfamiliar with the station's routines and practices. *Fig. 1* shows the form in which the check sheet is made up, and the routines are as follows:

Date.........194.....
DAILY ROUTINE CHECK SHEET Day.................

"A"	"D"	"B"	"E"	"C"	"F"
1	3	1	4	1	2
2	4	2	6	16	3
6	5	3	7	19	4
7	18	5	8	20	5
8	19	11	9	23	6
9	20	12	10	25	7
10	21	13	14	26	8
11	26	14		27	9
12	32			28	10
13	33			29	11
14	37			30*	12
15	38			35*	13
16	39			36*	14
17	40			40*	15
22	41			41*	17
23	45			42*	18
24	46			44*	19
25	48			46*	21*
27	52*			47*	22
28	54*			48*	24
29	55*			49*	26
30				50*	27
31				51*	28
34				52*	31*
35				53*	32*
36				54*	33*
45				55*	34*
46				56*	37*
47				57*	38*
48				58*	39*
49*					40*
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					49*
					50*
					51*
					52*
					53*
					54*
					55*
					56*
					57*
					58*

* means other than daily
All others are daily items

FIG. 1

The daily routine check sheet. The numbers designate specific duties to be performed on the "A" to "F" shifts, as described in text.

"A" and "D" Shift, Daily Routine

1. *One hour before program time,* turn on all bays and speech input equipment.
2. Start Transmitter Log.
3. Check and *log* gas pressures on both lines on 46th floor.
4. Check and *log* gas pressures on eight lines in Doghouse.
5. Open manually-operated shutters in both air ducts of Trane cooler on 46th floor.
6. Remove grounds from Driver and 50-kw tanks and transmission lines, and plate transformer on 46th floor.
7. Turn on spare 869 rectifier preheater.
8. Check air intake in P.A. room.
9. Check and *log* P.A. room temperature.
10. Check P.A. room exhaust fan.
11. Check and *log* temperature in Power Control-Rectifier room.
12. Turn on spare 872 rectifier preheater.
13. Check air intake in Driver room.
14. Check and *log* Driver room temperature.
15. Check Driver room exhaust fan.
16. Check and *log* outside temperature.
17. Check I.P.A.—Driver blower.
18. When shift-mate has returned from 46th floor: *Start* transmitter (P.A. with minimum power, Driver with normal power) and observe timing of all relays.
19. Rough-check neuting, but *do not* readjust unless absolutely necessary.
20. When all four phases have been checked at 220 volts, set following meters to normal according to tuning records and meter logs:
    a. Bias filament voltmeter;

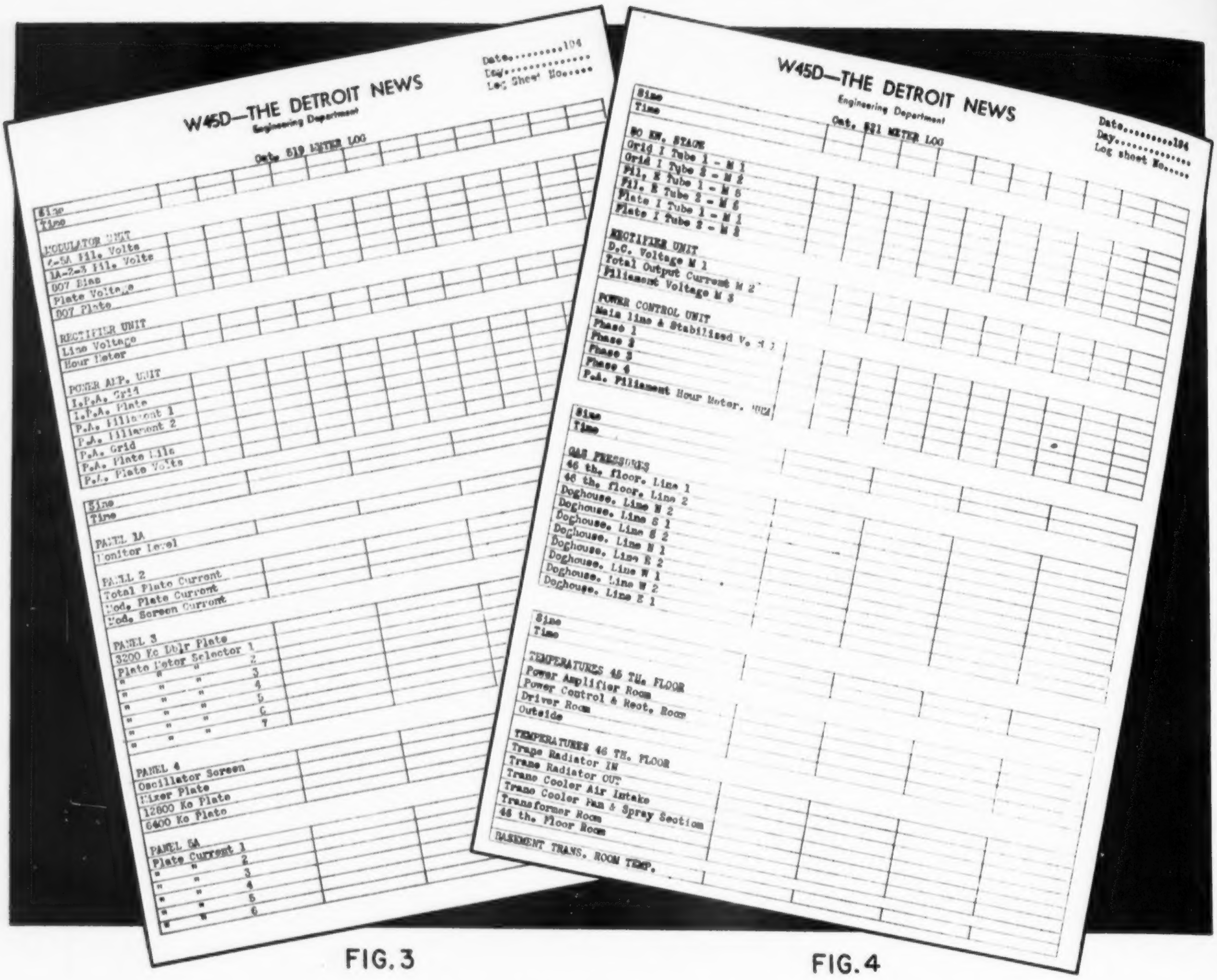


FIG. 3 FIG. 4

Engineering log sheets used for keeping data on operation of equipment.

b. P.A. filament voltmeter, both positions;
c. Grid-current meters, both tubes;
d. Plate-current meters, both tubes;
e. Total plate current;
f. Plate voltage (minimum);
g. Water-flow meters.

21. Rough-check Modulator Unit stages, I.P.A., and Driver for normalcy.
22. Check NBC and WWJ loops for proper level and noise.
23. Make frequency run on alternate Turntables through all normal speech input equipment and Transmitter, using frequency record, and *log* results briefly on Transmitter Log.
24. Check both Turntables and Q Amplifiers for normalcy.
25. Meter currents and voltages of all audio equipment and *log* on proper form.
26. Check all clocks against Western Union clock, and correct when necessary.
27. Check all mikes and mike channels for normal operation.
28. Check all keys, faders, relays, and selectors for normalcy.
29. Check all amplifiers for normal operation.
30. Check accuracy of time tick oscillator 30 minutes before start of program.
31. Check automatic remote Q circuit.
32. *After 15 minutes of low power operation*, and *before going to full power*, check the following 46th floor items:
    a. Bearings of filament motor-generator set;
    b. Bearings of pumps and pump motors;
    c. Bearings of blower and blower motor;
    d. Bearings of fan motor;
    e. General heating of all rotating equipment;
    f. Temperature rise of circulating water and thermostatic operation of fan and spray pumps, as associated with prevailing temperatures;
    Note: Temperatures below 105: Fan off, Spray off; temperatures 105-110: Fan on, Spray off; temperatures above 110: Fan on, Spray on.
    g. Operation of Damper motors by opening toggle switch in low-voltage circuit in Sub-control Cabinet. On reclosing of switch, dampers should assume intermediate positions, depending upon prevailing temperatures;
    h. Differential temperatures at output of blower, and ahead of, and behind water cooler;
    i. Cooling system alarm bell by opening toggle switch in coil circuit of spray pump motor starting contactors in Sub-Control Cabinet, at 130°.
33. Increase to *full power*.
34. Recheck all meter readings for normalcy.
35. Fine-tune and fine-neut P.A.
36. Check GR 620-A against WWV and measure carrier frequency. *Log* on Transmitter Log and on Frequency-Measuring Log.
37. Recheck all 46th floor items.
38. *Log* all Transmitter meter readings and temperatures on proper forms just before starting regular program schedule.
39. *Log* all meter readings as required by F.C.C., every half hour.

40. *Log* all transmitter meter readings on proper forms every two hours.
41. Check all items on 46th floor hourly.
42. At about middle of shift, check all tuning adjustments.
43. At about middle of shift, visit and check basement transformer room.
44. At about middle of shift, visit and check 46th floor transformer room.
45. Enter all discrepancies on Transmitter Log.
46. Enter all maintenance work in Work Report Book.
47. Before going off duty, total and enter program time on back of Transmitter Log.
48. Acquaint your relief man with any and all unusual items that occurred on your shift.

Note: On Sunday of every week, *in addition to daily routine*, do the following:

49. Check water flow interlocks.
50. Check air flow interlocks.
51. Check filament supply filter fuses.
52. Check and clean filters in water supply.
53. Measure Bias Supply voltage, and *log* on Transmitter Log.
54. Check filament m.g. set bearings for play, commutator for scores, brushes for wear, tension and seating, and any replacement requirements.
55. Check and service Relay Supply m.g. set in shop.

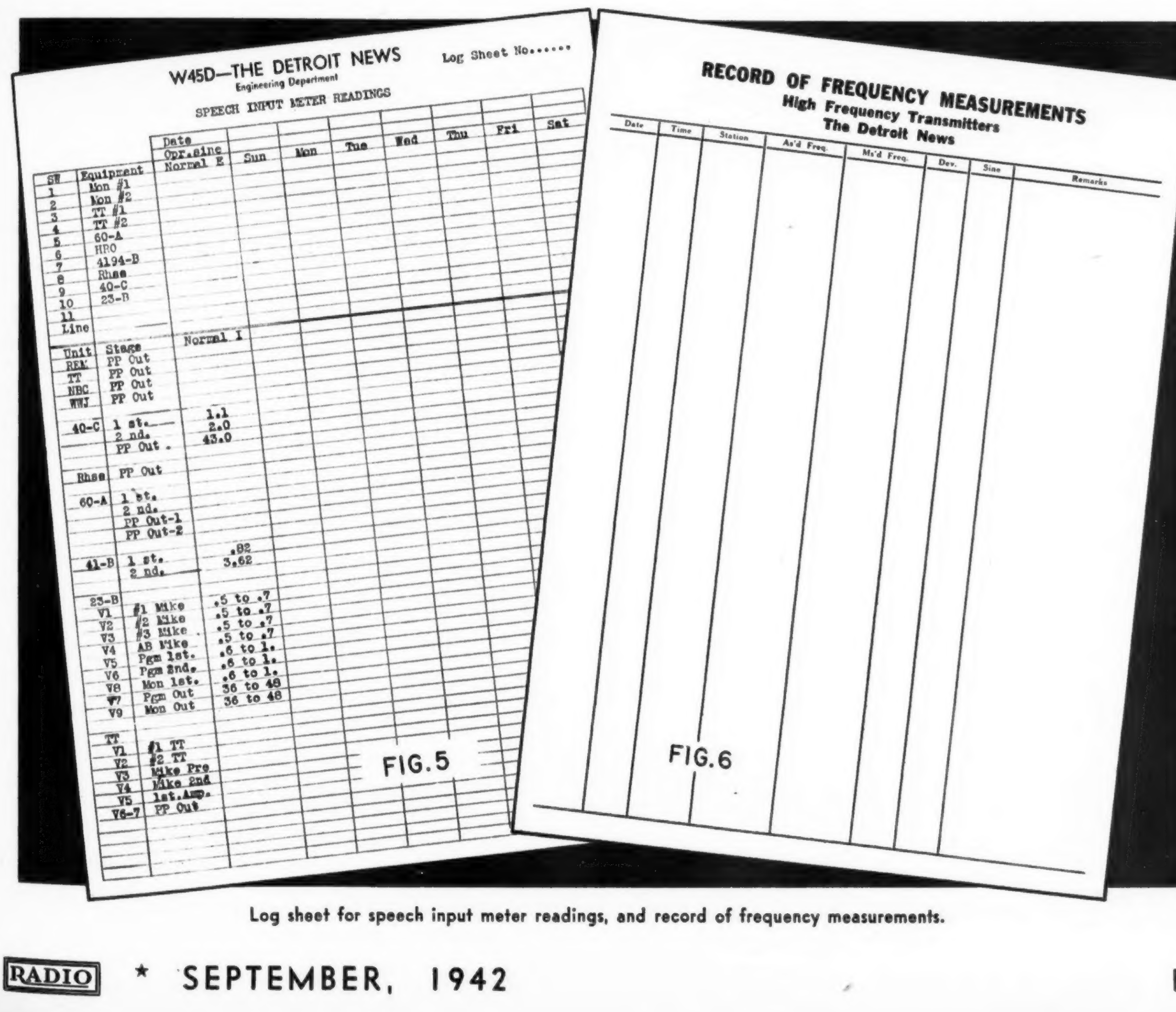
"B" and "E" Shift, Daily Routine

1. Start new Transmitter Log.
2. *Log* Transmitter meter readings every half hour, as required by F.C.C.
3. Early during this shift, check GR 620-A against WWV and measure carrier frequency. *Log* on Transmitter Log and on Frequency-Measurement Log.
4. Check all items on 46th floor hourly.
5. At about middle of shift, check all tuning adjustments.
6. At about middle of shift, visit and check basement transformer room.
7. At about middle of shift, visit and check 46th floor transformer room.
8. Once per shift, check and *log* gas pressure on 46th floor.
9. Once per shift, check and *log* all temperatures on proper form.
10. Every two hours, *log* all Transmitter meter readings on proper form.
11. Enter all discrepancies on Transmitter Log.
12. Enter all maintenance work in Work Report Book.
13. *Before* going off duty, total and enter program time on back of Transmitter Log.
14. Acquaint your relief man with any and all unusual items that occurred on your shift.
15. Assist C.E. with records and paper work, when needed.

"C" and "F" Shift, Daily Routine

1. Start new Transmitter Log.
2. *Log* Transmitter meter readings every half hour, as required by F.C.C.
3. Early during this shift, check GR 620-A against WWV, and measure carrier frequency. *Log* on Transmitter Log and on Frequency-Measurement Log.
4. Check all items on 46th floor hourly.
5. At about middle of shift, check all tuning adjustments.
6. At about middle of shift, visit and check basement transformer room.
7. At about middle of shift, visit and check 46th floor transformer room.
8. Once per shift, check and *log* gas pressure on 46th floor.

[*Continued on page 36*]



Log sheet for speech input meter readings, and record of frequency measurements.

Equalization of

CLASS C PROGRAM LINES

JAMES L. STAPLETON

Chief Operator, KOB

◀ Many American broadcast stations use network program lines known as Class "C" lines. These circuits are decidedly inferior in audio quality, but for reasons of economy are used instead of Class "A" lines.

The frequency response on a Class "C" line is very poor compared to Class "A" service. In the bass range the response curve is down 30 to 35 db at 100 cycles from a 1000 cycle reference. In the high end the response is down approximately 9 db at 4000 cycles. If the circuit can be equalized so that it has substantially flat response from 100 cycles to 4000 cycles most of the "tinny" quality is eliminated and a much more listenable service results.

Frequency Characteristics

Fig. 1 shows the frequency characteristics of the Class "C" program line with the limits of variation as maintained by the American Telephone and Telegraph Company. This chart is supposed to represent all possible combinations of Class "C" circuits used in this country. Obviously, no one equalization curve can correct all the variations possible within these limits.

A departure from the usual equalization procedure has been made at KOB with good effect. We have found it to be flexible, economical, and simple to operate. This equalizer will be described, but possible changes will be included to meet conditions found at other stations.

Fig. 2 is the diagram of our Class "C" line equalizer. The parts are in no way critical and in most instances should be found in any broadcast station's parts stock.

Circuit Design

The basis for this equalizer circuit is the Wien bridge, application of which was described by H. H. Scott in the *Proceedings of the Institute of Radio Engineers*, February, 1938, and by Ray L. Dawley in RADIO, June, 1940. The chief problem in putting this circuit to

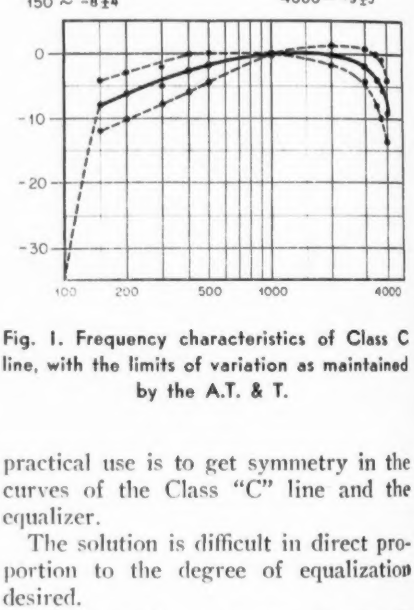


Fig. 1. Frequency characteristics of Class C line, with the limits of variation as maintained by the A.T. & T.

practical use is to get symmetry in the curves of the Class "C" line and the equalizer.

The solution is difficult in direct proportion to the degree of equalization desired.

In *Fig. 2* the resistances R_1 and R_2 are indicated as being one megohm each. However, by varying the resistors and retuning with capacity to 100 cycles the slope of the curve can be controlled satisfactorily. In varying R_1 and R_2 from ½ megohm to 3 megohms, a 10-db change in response could be had at 120 cycles with the 100-cycle peak remaining the same. *Fig. 3* shows this variation. The formula $C = \dfrac{10^6}{2\pi R}$ should be used to calculate the capacity needed (C in microfarads, R in ohms). In changing these capacities and resistances, be sure to maintain conditions whereby the equalizer can be made to oscillate by running up the regeneration

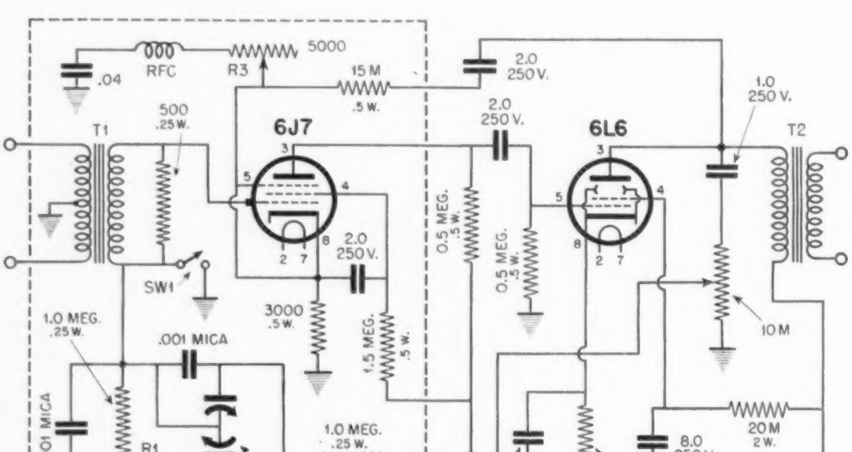


Fig. 2. Diagram, with parts values, of the Class C program line equalizer. The choke RFC is cut to resonance at 5000 cycles. T1 is a repeater transformer, or 1-to-1 ratio, with center-tapped primary. T2 is a universal output to 500 ohms.

control. Just before oscillation takes place, a peak as high as 50 db can be had.

On the high end, the curve was corrected by the rather simple trick of shunting the inverse feedback circuit with a series-resonant circuit tuned to 5000 cycles. The heighth of this peak is controlled by the series resistor, R_3, in *Fig. 2*.

Since the bass response is down between 30 and 35 db at 100 cycles, it is impractical to attempt to equalize flat to lower frequencies. Should any ambitious soul try working below this limit, he will find himself involved with severe distortion.

In the high range of the Class "C" circuit equalization is limited by carrier frequencies which begin in the vicinity of 5,500 cycles. No great effort has been made to equalize beyond the 4,000-cycle point because data on this range of frequencies is lacking, and because it is easy to bring up carrier sing to a point of annoyance.

The variable condenser incorporated in the design is essential if close tolerances in equalization are to be maintained. It is necessarily insulated from ground. Since the bass response is not necessarily fixed, variations here have been known to be as extreme as 20 db at 100 cycles. This necessitates retuning the peak to a higher frequency. A capacity of .00035 μfd. per section gives a variation in the peak from 95 to 120 cycles. The switch *SW1* has been very

F	0.5 MEG.	1.0 MEG.	3.0 MEG.
1000 ~	0	0	0
500 ~	1.5	1.0	0.5
250 ~	6.0	4.5	2.5
150 ~	14.0	10.0	7.0
120 ~	22.0	17.0	12.0
100 ~	37.0	37.0	37.0

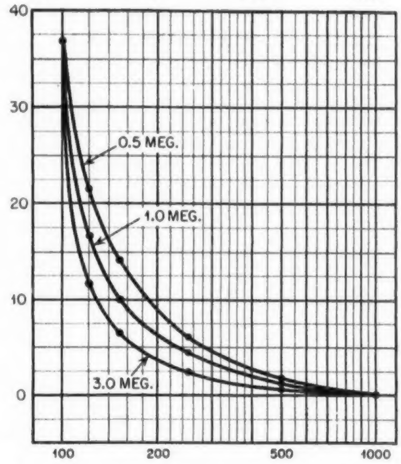


Fig. 3. Effect of resistance on the slope of the curve; by change of values of R1 and R2 in Fig. 2.

useful here, since at times we have been changed to Class "A" service without advance notice.

Any ordinary power supply should be satisfactory for this equalizer, though some additional filter may be necessary. It being essential to protect this equipment from parts that may induce 120 cycles, the power supply should be kept separate and at a little distance. The noise level on this equalizer connected to the line was 45 db down, noise consisting mostly of carrier sing.

Running Curves

In running curves on this equalizer it is important to have a well-calibrated audio oscillator. If there is any doubt about its calibration, an oscilloscope should be used, with the power-line frequency for reference. On the steep slope of the curve an inaccuracy of 10 cycles is drastic. It is also suggested that if there is no control at the originating end of the circuit that equalization be determined by ear rather than attempting to get a 100-cycle point from the telephone company. This should be done by connecting the equalizer to the station monitor and making adjustments until it sounds as natural as possible. Then install the equalizer for program service, using the same adjustments. For final alignment check with a good quality push-button receiver against a station known to have a Class "A" line and carrying the same program as your station. It is possible to set this equalizer so that your station, served by a Class "C" line, gives very satisfactory comparative quality.

The equalizer should be checked about once a week because of aging tubes and variations in the Class "C" circuit. The only precaution is not to let it break into oscillation if it is adjusted while in service. The advantages of the circuit will be more apparent the longer it is in use.

AIRCRAFT DETECTION AND SOUND

WILLARD MOODY

◀ There are certain types of people who go overboard when war strikes, and it seems these individuals come up with such ideas as using microphones and amplifiers, or horns, for the purpose of picking up the sounds of airplane engines at a distance. All this, when the fact of the matter is that by the simple exercise of arithmetic and common sense we can see the fallacy of expecting an airplane detection system based on auditory apparatus to function efficiently.

It is true that the Army has such sound-detection apparatus, but the horn collectors must be of a special type, soundproofed to keep out external noise and to offer as much selectivity as possible. In all probability, such apparatus is not used so much for aircraft detection as it is for spotting guns and getting their position. There is nothing secret about this and the facts are well known, and easily obtained from books on sound. The details of equipment used by the armed forces are, naturally, secret, and civilians can't expect to construct such apparatus even if it does work. For one thing, it is a definitely proven principle of physics that supersonic or ultrasonic audio signals having frequencies beyond the range of audibility, do not travel efficiently through air but do travel fairly well through such mediums as water and substances having somewhat similar properties. For this reason, supersonic equipment has been used for sounding of harbors and also has been employed by submarines for determination of distance of ships, to get the range. The fascinating notion that supersonic equipment is used for aircraft detection would seem to be, on the basis of information available to civilians, quite naive.

Plane and Sound Velocities

In order to clarify the situation, let's examine the relative velocities of plane and sound. If the plane is traveling at the rate of 500 miles per hour, the speed per minute will be 500/60 or 8.33 miles/minute. For various other speeds, then, we have:

miles/hour	miles/minute
400	6.66
300	5
240	4
200	3.33
180	3
120	2
60	1

The speed of sound at normal temperature, around 70 degrees Fahrenheit, is 1100 feet/second. This is .2 mile/second or 12 miles/minute and 720 miles/hour.

Suppose that we have two points 12

[*Continued on page* 45]

Q. & A. STUDY GUIDE

—Theory and Practice

215. What is meant by "counter c.m.f." in a d.c. motor?

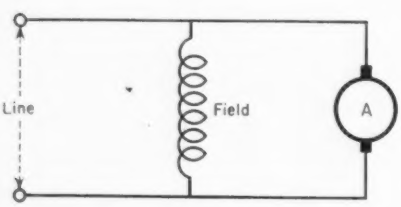
It is the electromotive force induced in the motor armature by the conductors of the rotating motor armature cutting the lines of force of the field, similar to the armature in a generator. The induced voltage is opposite in polarity to the voltage applied to the motor, and may be determined by operating the motor as a generator (at rated speed) and measuring the output with a voltmeter.

216. What determines the speed of a synchronous motor?

The frequency of the source of power and the number of poles of the motor, using the formula:

$$S = \frac{120f}{P}$$

where S = speed
P = number of poles
f = frequency in cycles per second.



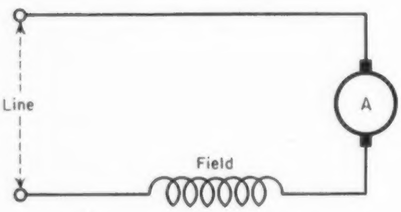
SHUNT-WOUND D.C. MOTOR
FIG. 1

217. Describe the action and list the main characteristics of a shunt-wound d.c. motor.

See *Fig. 1.* The field winding is shunted directly across the line, with the flux practically constant. For excitation only part of the current supplied by the line is used, and this is shunted across the armature by way of the field winding. The shunt motor has the advantage of constant speed; i.e., the speed changes but slightly with variations in the load. The speed may also be adjusted, being increased by inserting resistance in the field, and decreased by inserting resistance in the armature circuit. The latter method is inferior since it reduces efficiency of operation also.

218. Describe the action and list the main characteristics of a series d.c. motor.

See *Fig. 2.* The armature and field are in series with the line. The applied

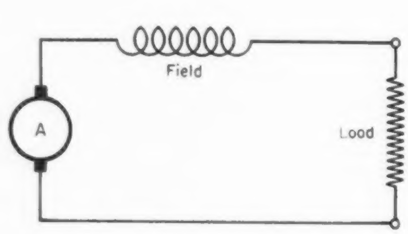


SERIES-WOUND D.C. MOTOR
FIG. 2

voltage is constant and the field excitation increases with the load. As the load and armature current decrease the flux per pole will also decrease and the motor must speed up to provide the required back e.m.f. Consequently, always *gear*, not belt, a series motor direct to load; otherwise, should a belt slip or break, thus removing the load, the motor will speed up past a safe point. In regulating, the speed may be changed by altering the applied voltage or the flux per pole; to reduce speed, insert resistance in the armature circuit, and to increase speed, reduce excitation by shunting the field winding. Although the speed of the series motor is unstable relative to the load, its starting torque is quite large, making it practical for cranes and similar devices, where constant speed is not a factor, but where heavy loads are to be moved.

219. Describe the action and list the main characteristics of a series d.c. generator.

The load, field, and armature are connected in series. See *Fig. 3.* The field is of heavy wire, has few turns, and is capable of carrying the load current. Excitation of the field magnets is dependent on the resistance of the external circuit, since all current generated in the armature passes through the field windings, to excite both these and the external circuit. Output voltage and current can be varied by shunting resistance across the field coils.



SERIES-WOUND D.C. GENERATOR
FIG. 3

220. To obtain an output frequency of 60 cycles per second, a 6-pole alternator must be driven at what number of r.p.m.?

Solve by formula $f = \frac{PS}{60}$

where f = frequency in cycles per second.
P = number of poles
S = r.p.m. of armature or field.

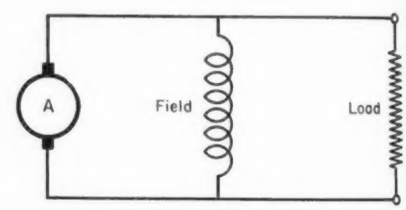
thus $f = 60$
$P = 6$

to find S:

$$60 = \frac{6S}{60} = 600 \text{ r.p.m.}$$

221. Describe the action and list the main characteristics of a self-excited, shunt-wound d.c. generator.

The field magnets (see *Fig. 4*) are excited by a small part of the armature-generated current. The exciting current



SHUNT-WOUND D.C. GENERATOR
FIG. 4

is largely independent of the load, since it passes through the field winding without passing through the external circuit. Voltage is controlled by inserting resistance in series with the field. There should be sufficient residual magnetism in the generator to start building up voltage; if not, a small source of power must be connected to provide the necessary flux. The voltage provided by the residual magnetism will start the generator, thereby building up the voltage produced by the generator, which in turn increases the flux, and the generator voltage again increases, etc., until a saturation point or stabilization point has been reached.

222. Describe the action and list the main characteristics of a flat-compounded d.c. motor.

See *Fig. 5.* The compounded motor [*Continued on page 35*]

FROM BROADCAST TO TELEVISION

The Station Operator Is Confronted With New Problems and Duties When He Takes On a Television Transmitter. The New Operating Concepts Are Detailed Here.

EDWARD M. NOLL

PART II

As we stated in the previous article, the entire television channel is limited to 6 megacycles. The picture carrier is located 1.25 megacycles from the low-frequency end of the channel, and the sound carrier is located 5.75 megacycles

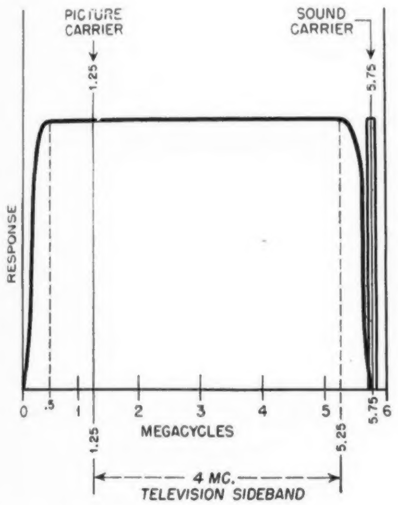


Fig. 1. The RMA Standard Television Channel, limited to 6 megacycles. This curve shows the disposition of the picture and sound carriers in relation to total bandwidth.

from the same end. The aspects of the RMA Standard Channel are shown in *Fig. 1.*

The Video Transmitter

The oscillator of the video radio-frequency section is generally crystal-controlled and in the region between 6.5 and 12 mc so that it may be conveniently doubled, then tripled, to the required frequency between 44 and 72 mc.

The stages following the tripler build the r-f signal to the required output. They are generally Class C push-pull transmission-line amplifiers of the type shown in *Fig. 2.* The transmitter operator must become acquainted with the many advantages of this type of amplifier which has been found to be most efficient and convenient at the high frequencies required. The tubes utilized for this service are recently-developed air-cooled types with cooling fins for medium powers, and for the higher powers ultra-high frequency water-cooled tubes. Tubes must be adequately cooled with fans and blowers at these frequencies, as the heating caused by circulating tube currents is high. Circulating currents are high due to the low reactance of interelectrode capacities at ultra-high frequencies.

The push-pull parallel-line construction presents a convenient mechanical means for mounting neutralizing condensers, shorting bars, and tuning condensers so as to prevent the stray inductance and capacity of long wire leads. The parallel lines are made up of quarter-wave or half-wave lines shorted or open circuited, depending upon the characteristics of the tank circuit desired. The design of the lines is an engineering project, as the inductance of tube leads and interelectrode capacities, as well as stray inductance and capacity, must be carefully considered. The distributed inductance and capacity make up the frequency elements of the circuit and are tuned by means of shorting bars or disk condensers.

The push-pull circuit is a definite aid in obtaining sufficient neutralization and its symmetrical mechanical construction reduces the capacity effect of nearby objects.

In the Class B r-f stages or modulated r-f stages for television application, damping resistors must be utilized in the grid or plate circuits to insure flat frequency response from carrier frequency to approximately plus 4 mc and minus 2 mc. These damping resistors reduce the efficiency of the amplifier considerably and they must be able to dissipate a goodly amount of heat; in some installations, water-cooled resistors must be used. In the voltage feed circuits of the amplifiers a mica condenser is generally paralleled with the usual bypass condenser to take care of the bypassing of the very high frequencies where the ordinary bypass condenser be-

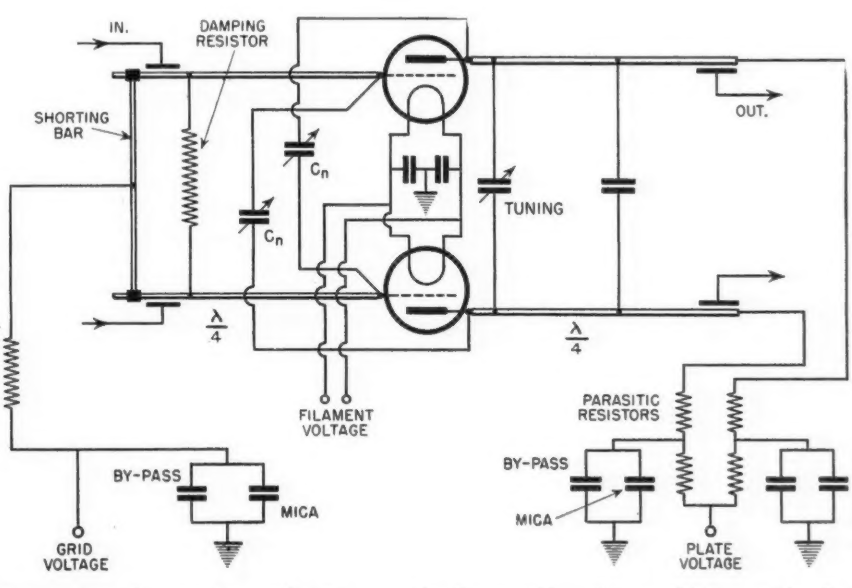


Fig. 2. Basic diagram of a push-pull transmission-line amplifier. The parallel line construction presents a convenient mechanical means for mounting neutralizing condensers, shorting bars and tuning condensers so as to prevent the stray inductance and capacity of long wire leads.

comes inductance in operation.

The modulated radio-frequency signal is applied to the sideband filter which removes and dissipates a portion of the low-frequency sideband. The filter consists of a group of coaxial transmission lines, one operating with a capacitive

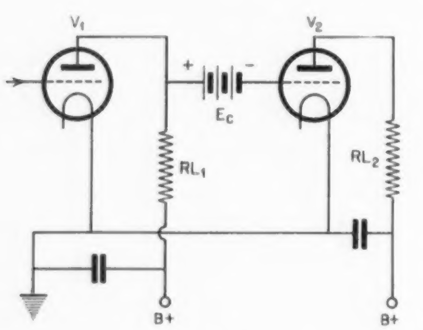


Fig. 3. Basic diagram of a direct-current amplifier for video use. This prevents the one-polarity signal from alternating about an axis.

reactance (greater than ¼-wave line) which passes the higher frequencies to the antenna, and another operating with an inductive reactance (less than ¼-wave line) which passes the lower frequency portion of the sideband to a resistor where it is dissipated in the form of heat.

The signal is then ready for application to the antenna. The television antenna, like the wideband amplifiers, must have a flat response, and in order to accomplish this it must present a constant impedance to the final amplifier over the frequency range required. This is obtained by mechanically constructing an antenna which, by the proper proportioning of inductive and capacitive components in a constant-impedance network, will present an impedance to the final stage constant and purely resistive. It is generally a turnstile arrangement of coaxial transmission-line sections.

The Sound Transmitter

The sound carrier is located 0.25 mc from the high-frequency end of the band and the sound channel is permitted a total deviation of ± 75 kc or a total bandwith of 150 kc. The sound oscillator operates in the vicinity of 10 mc so it can also be conveniently doubled and tripled to the required frequency. The deviation at oscillator frequency is ± 12.5 kc which is increased correspondingly to ± 75 kc at the required frequency.

The deviation of frequency is controlled by a reactance modulator which varies at the frequency of the oscillator in accordance with the audio signal applied. It must be capable, in order to obtain the best audio response, of varying the frequency in a symmetrical manner both sides of carrier frequency so that a sustained note of constant voltage amplitude would vary an identical amount each side of the carrier frequency. A decrease in voltage amplitude will cause a decrease in deviation, and an increase in voltage amplitude will increase the deviation up to a limit set by the limiting audio amplifier which functions in a similar manner to those utilized in broadcast stations, with the exception of not permitting a frequency deviation greater than ± 75 kc instead of preventing sustained over modulation peaks.

Frequency modulation permits a considerable saving in audio equipment and power as only a small audio voltage is required for modulation. In addition, under proper operating conditions, a higher signal-to-noise ratio and a better audio-frequency response is possible at the receiving location.

In order to secure the utmost in frequency response the operator must see to it that all the r-f stages are properly tuned and neutralized, permitting them

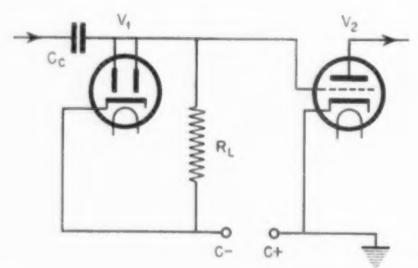


Fig. 4. Another form of direct-current amplifier. The diode rectifies the television signal and produces a voltage approximately equal to the peak of the television signal across RL.

to produce symmetrical deviation. The sound antenna is a peaked array because of the small frequency band emitted, and may consist of four dipoles, or folded dipoles, depending upon the transmission line construction and the matching system. The audio signal can be monitored on the line and by a signal piped in from a remote receiver. The sound and the picture carrier frequencies are monitored by a commercial frequency meter.

The Video Amplifier

The video amplifier section of a television transmitter may be compared to the equipment associated with audio amplifiers and modulators as utilized by broadcast stations. A signal of a few volts is to be amplified to that voltage which is required for proper modulation of the radio-frequency transmitter.

In the case of television, however, this signal is of one polarity instead of alternating about an axis as the audio signal associated with broadcast transmissions. This variation from normal necessitates the use of a different type of amplifier or the modification of a present type. An amplifier is required which will sustain a direct current component; that is, will not permit the signal to arrange itself as an average about an axis, thus destroying the construction of the television signal. Such an amplifier is called a direct-current amplifier.

A direct-current amplifier of the simplest type is shown in *Fig. 3*, and is a modification of a resistance-coupled amplifier as used in audio amplification. The battery *Ec* is the means of coupling between *V1* and *V2* and, in addition, sets the operating bias of *V2*. A more positive voltage applied to the grid of *V1* will increase its plate current and decrease the voltage across *RL1* which will correspondingly reduce the voltage applied to the grid of *V2* through *Ec*. This reduced voltage will decrease the plate current of tube *V2* and increase the voltage across *RL2*. Thus it can be seen that while each stage will operate approximately 180° out of phase the direct-current component will be maintained, the signal varying either one side or the other of the operating bias level, but never on both sides. It can also be seen very definitely the magnified result through successive amplifiers of any small variations in potential in any portion of the circuit. Therefore the operating point of each stage must be adjusted precisely and all applied electrode voltages must remain constant and free of ripple; thus the necessity for exceptionally well regulated power supplies to produce the tube potentials.

The use of a d-c potential source as a method of coupling is restricted to low television signal potentials. Beyond a certain potential the physical size of the

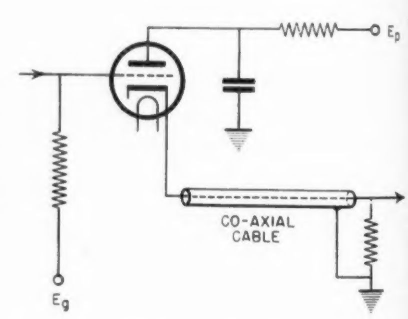


Fig. 5. A cathode-coupled stage with coaxial line. Gain is less than unity, but the circuit provides an ideal means of coupling a high impedance to a low impedance.

coupling source and its increased capacity to ground will cause serious degeneration of the high frequencies involved. For larger potentials another variation of resistance coupling is used. In this

system, as shown in *Fig. 4*, a diode rectifier and its load resistor is shunted across the output of the interstage coupling system. The diode rectifies the television signal and produces a voltage approximately equal to the peak of the television signal in its load resistor. The peak of the television signal, as you know, is the tip of the sychronization pulses and is of a constant amplitude with respect to the blanking level. The additive effect of this component and the proper amount of applied bias determines the operating point of tube *V2*.

Video Frequency Response

Thus far we have not mentioned the frequency response of the video amplifiers. We find that in order to meet the 4-megacycle requirements the plate load resistance of the video amplifier must be reduced to a very low value which correspondingly reduces the stage voltage gain to a painfully low value. In addition, in many cases, tubes must be operated in parallel so as not to exceed the plate dissipation of a single tube operating at normal potentials with such a low plate load resistance, the low plate load resistance having caused a serious increase in plate current. Therefore, in video amplification we must utilize more stages to make up for the deficit in voltage gain per stage. Throughout all the video amplifiers precautions are taken by means of constant-impedance networks and compensation filters to prevent degeneration of high and low signal frequencies.

Another type of amplifier used in video amplification is the cathode-coupled stage, as shown in *Fig. 5*. The stage has a gain of less than unity, its advantage being in its ability to couple from a high impedance to a low impedance at approximately the same voltage. The output is taken off the cathode at low impedance and since one side of the output is at ground potential and the other side requires no blocking condenser, as no potential is applied to the cathode, it can be conveniently coupled to a coaxial line, thus preventing any high frequency degeneration associated with capacity coupling.

This system presents an ideal method of coupling the television signal of the order of a thousand volts as grid modulation to the radio-frequency amplifier. The bias of the radio-frequency amplifier is conveniently applied on the same line and by controlling this bias the radio-frequency output of the transmitter is controlled, and by operating the bias at a point where the r-f amplifier plate current will saturate, the synchronization pulses can be flattened in case the ratio of picture to synchronization is too small.

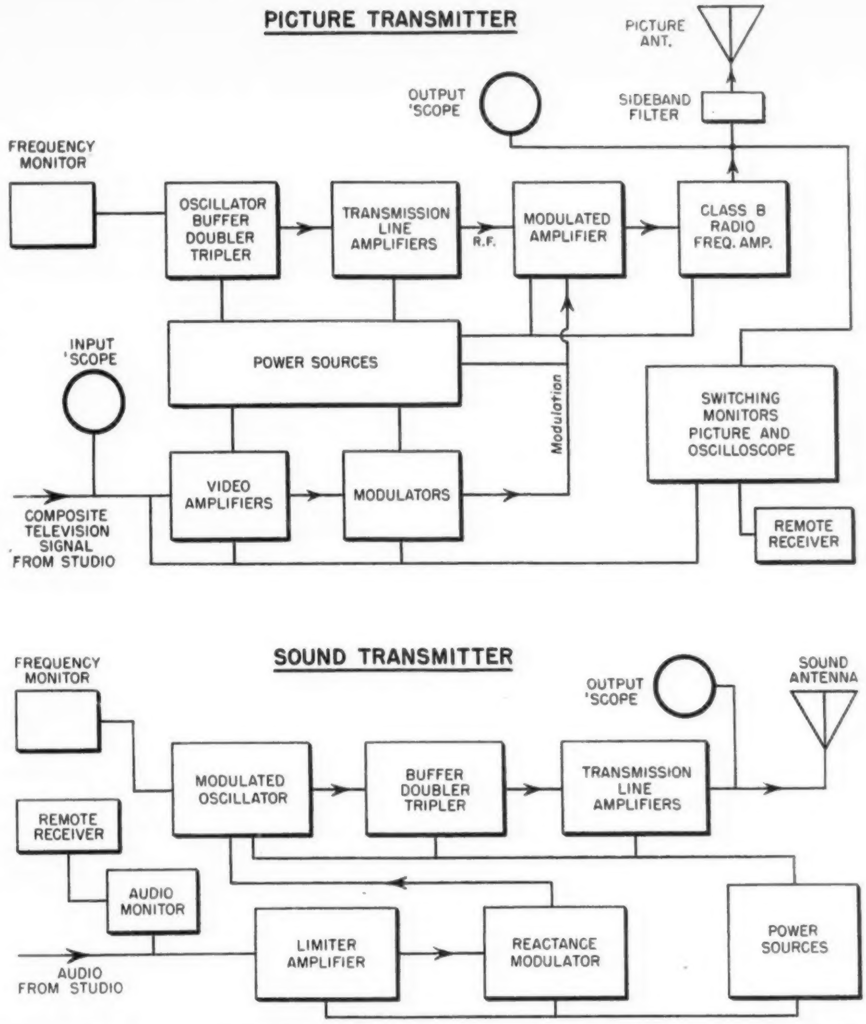


Fig. 6. Block diagram of complete television transmitter setup, with picture transmitter at the top and the sound transmitter at bottom. The various units composing both transmitters are described in the accompanying text. Note the three cathode-ray oscilloscopes used as picture and sound signal monitors.

Power Supplies

The power equipment utilized in the television transmitter is conventional except for that used in the video amplification and modulated radio-frequency stages. In the case of the lower powered video stages especially designed voltage-regulated power supplies are used, and in the higher powered video stages where voltage regulator tubes are not practical, the equipment is designed to be as well regulated and ripple free as possible.

The filaments of the higher powered stages are supplied with direct current from a motor-generator set in order to prevent alternating current from leaking into the video signal from the filament circuit. All circuits are well fused and interlocked for the protection of both the equipment and the operator.

A complete television transmitter setup, in block diagram form is shown in *Fig. 6*. This will serve to illustrate the points with regard to each section of the transmitter as covered in this article.

(Conclusion)

Book Review

RCA ISSUES NEW TUBE GUIDES

RCA announces the issuance of a new 16-page booklet on RCA Receiving Tubes and Allied Special-Purpose Types (Form 1275-B) as well as a new 1942 RCA Guide for Transmitting Tubes. Both publications are just off the press.

The RCA Receiving Tube booklet contains three charts. Chart I classifies RCA Receiving Tubes according to their cathode voltages and function. Chart II gives characteristics of each of 329 receiving types arranged in numerical-alphabetical sequence. Attention is directed to the type numbers set in light-face print. These types are included in the War Production Board's Limitation Order L-76 discontinuing the manufacture of certain receiving types for general civilian use. Chart

[*Continued on page 37*]

SEMI-AUTOMATIC COIL WINDING

BON L. WONG

Coil Department
Times Telephoto Equipment

Unless a manufacturer of communication equipment is producing quantatively, he is most likely facing the difficulty of getting finished coils and transformers. The reason is obvious, as the existing facilities normally devoted to manufacturing these products are already fully engaged to capacity by larger organizations.

However, a small manufacturer can overcome this handicap by setting up a coil department in his own plant. From the stand-point of economy and efficiency, it is more advantageous for him to employ the semi-automatic process rather than the automatic one. It is the purpose of this article to discuss the various elements involved in the semi-automatic process. The principle of operation of this method is the same as that of the automatic one; that is, the whole system is based on the application of correct tension, even layering of wire, and avoidance of straining of the wire while winding.

Operational Setup

Fig. 1-A shows the schematic layout on the working bench, and *Fig. 1-B* gives the relative position of bobbin and spool of wire with respect to that of the operator. The actual winding is done by rotating the bobbin; the best way to drive it is perhaps by a capacitor-start, capacitor-run, split-phase induction motor whose circuit diagram and starting performance are given in *Fig. 2*. If such a motor is not available, a single-phase or d.c. series motor is a satisfactory alternative. A motor of 1/50 horse power rating and about 1800 r.p.m. or slightly lower is quite satisfactory for the handling of all enamel wires from No. 26 to No. 42.

The bobbin is generally of square cross-section[1], and its length is about 1.5 times the side of the square section. The shaft of the bobbin must not be out of center; otherwise, the operator can not control and guide the wire and at the same time this eccentricity creates non-uniform tension which can easily break or stretch a wire until it really is the next smaller size. If the spool is too heavy and full of wire whose physical size is smaller than No. 39, it is advisable to rewind a portion of it on a light spool such as wood, aluminum or magnesium to reduce the combined moment of inertia. This will prevent the unwinding of many feet of wire from the spool to the floor, when operation is suddenly stopped. Likewise, it helps the operator greatly to start the winding at the beginning of each layer. To insure uniform winding, attention should be given to reducing the vibration of the rotating shaft to a minimum. The disk, aluminum or steel, is for this purpose. It also serves as a hand-brake to control the speed of the motor.

[1]Circular C74, National Bureau of Standards, Washington, D. C.

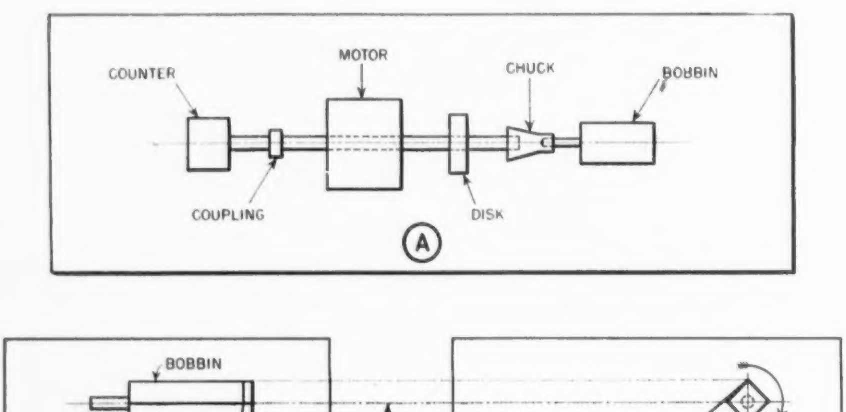


Fig. 1. Layout of work bench, and relative position of bobbin and spool of wire with respect to the operator.

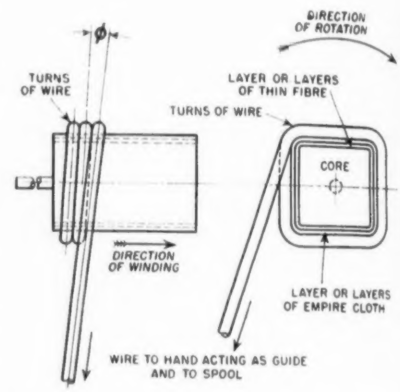


Fig. 3. Illustrating the fundamentals of winding on bobbin of square cross-section.

Fundamentals of Winding

Fig. 3 illustrates the fundamentals of winding. The first few turns on each layer as a rule are wound very slowly. After this preliminary step is completed, speed can be increased rapidly until amost at the end of the layer, provided the angle ϕ between the last turn and the one preceding it is kept constant. The size of this angle is different for different sizes of wire, but in general it is not greater than 10°. To make this angle remain constant while the bobbin is rotating at high speed is rather difficult, since the transversal movement of the hand guiding the wire must necessarily follow the same rate as

the number of turns being wound on the bobbin. Again, this rate is not fixed for all sizes of wire. However, once this technique is acquired through experience, the actual time consumed for winding a given coil is almost insignificant in comparison with that in feeding interleaving paper between layers, making adequate insulation between windings and to the core, and soldering connecting leads.

The usual method of construction of transformers used in push-pull amplifiers and full-wave rectifiers is known as the "unbalanced" secondary winding. As shown in *Fig. 4-A*, the tap is taken out at the middle of the secondary. Obviously, the half of the secondary next to the core has a higher shunting capacity and lower resistance than does the other half, but likewise possesses a lower leakage inductance with respect to the primary winding. As a result, the voltage delivered by the two halves of the secondary winding are not the same. This is not satisfactory if high quality of operation is necessary. A better way of construction is shown in *Fig. 4-B*. The primary is wound in the usual manner, but the halves of the secondary must be dealt with separately, as indicated in the sketch.

Wire Guiding

Since crossing turns must be avoided, the position of the hand guiding the wire is important. It is generally held at a distance of 5″ to 7″ from the bobbin. In the event that this distance is exceeded, the wire will vibrate, and crossed turns and unequal pitch of turns become inevitable. Consequently, the operator must stop winding in order to unwind the unwanted turns. The speed of winding a coil depends on three factors: (1) on adequate supply of tools and materials easily accessible to the hand, correct bench height, and comfortable seating; (2) speed of motor or bobbin, controlled through a variable-speed switch by the foot of the operator, and (3) the rate of transversal movement of the wire or perfect coordination between hand and foot.

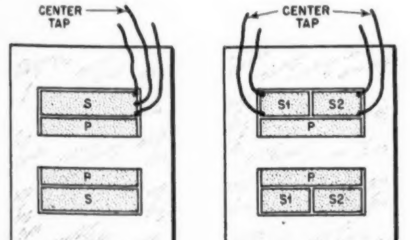


Fig. 4. Unbalanced and balanced secondary windings in push-pull transformers.

Improper Winding

Unequal pitch of turns results in uneven layers. Since coils usually must be compact, uneven layers make the physical size of the coil larger than the design calls for. Thus, final assembly of the over-sized coil becomes insurmountably difficult, if not impossible. What is more important is the decrease in space factor and thermal-conductance ratio[2]. Space factor is equal to the copper volume divided by the coil volume; the thermal-conductance ratio may be defined as the heat conductivity of the coil divided by the conductivity of the insulation. From *Fig. 5*, it can be readily seen that gain in heat-carrying capacity of a coil for given temperature difference is about proportional to gain in space factor over uneven layers, a definite gain in heat conductance is obtained.

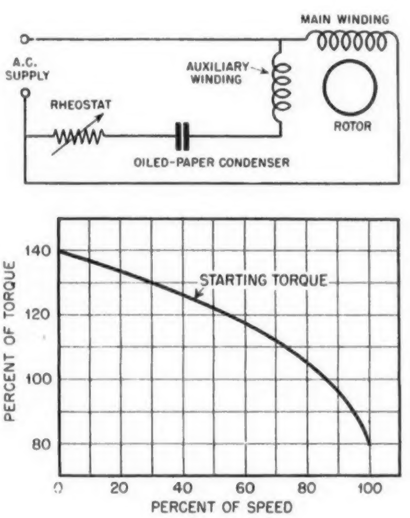


Fig. 2. Circuit of capacitor-start, capacitor-run induction motor and its starting performance.

Fig. 6 represents the decrease of inductance in the primary as well as the secondary of an air-core transformer when a number of turns is shorted intentionally in the secondary. The Q likewise decreases. Primary and secondary are wound with 900 turns of No. 34 enamel wire. A similar situation would exist if crossed turns were not detected and eliminated during winding, since enamel on the wire is easily broken under stress. The generalization is that a few shorted turns may make the coil or transformer useless. For instance, the amplification of a transformer-coupled amplifier in the low range of frequencies is reduced if the primary inductance is smaller than specified. It should also be pointed out that pressing the coil manually or otherwise may cause shorted turns; laminating the coil carelessly may produce the same result, if not a ground or an open circuit.

[2] "Fundamentals of Electrical Design", by A. D. Moore.

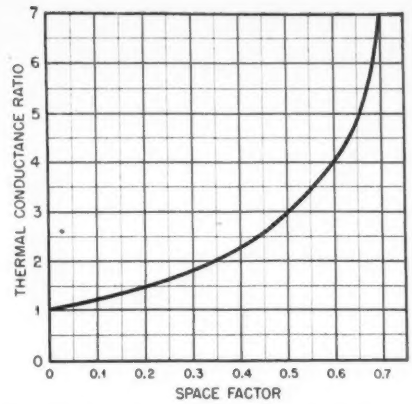


Fig. 5. Coil space factor plotted against thermal conductance ratio.

In all cases, the completed coil should be impregnated with insulating varnish and dried either in air or baked in an oven. If the latter is used, the temperature should preferably be 210° F. Common varnishes or shellac are not suitable, because they usually have a high moisture content; special kinds are commercially available for this purpose. Full facilities should be provided for routine testing purposes.

Illumination

Another factor relative to the efficiency of winding is that of inadequate illumination over the working area. Failure to recognize this fact invites ocular discomfort and fatigue to the operator, and a consequent decrease in efficiency and production. Generally speaking, many plants still have high

[*Continued on page* 36]

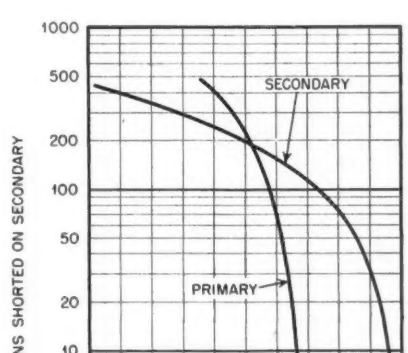


Fig. 6. Decrease in primary and secondary inductance in relation to number of shorted turns.

AUDIO BRIDGE OSCILLATOR

With Built-In Calibrator

A. K. McLAREN

◀ Frequency enters into most electrical formulae, and a variable-frequency source makes it possible to take measurements at several different frequencies. This is necessary in some applications and a calibrated source is necessary in any case.

The variable frequency audio oscillator described here contains a 60-cycle built-in calibrator which makes it self calibrating after it is once properly adjusted. This may be accomplished by comparing it with another oscillator of known accuracy, or it may be calibrated by using frequency charts and a piano as a comparison frequency source.

The oscillator uses a variation of the Wein bridge for control of frequency, and has a range from 20 to 15,000 cycles, depending on the transformers used.

Construction

The components are mounted in a wood case eight inches square. A metal case would be better but is not a necessity.

In the panel view the 2E5 electron-ray tube is in the upper left corner, and directly below it the cathode rheostat *(R1)* adjustment for the oscillator tube. The shaft is sawed off short and a screwdriver slot sawed in the end of shaft. In center is main dial. At the upper right is the frequency range switch. At right center are the output pin jacks, and at lower right the a.f. output control *R15*.

The dual potentiometer *R4-R5,* of 10,000 ohms each unit, are not only of the same resistance but must have the same taper. If a dual potentiometer of this type is not procurable, use separate, linear wire-wound units ganged together, and adjust each one to 5,000 ohms at center before locking. The ones used in this unit were ganged by mounting them on small metal strips and locking them together by means of an old style dual tuning unit.

The 3-to-1 audio-frequency transformer *T1* should be a good quality unit for best low-frequency response. The transformers are connected so as to give both positive and negative feedback. Transformer *T1* furnishes the positive feedback and should be connected so that oscillation can be established before the other parts are connected. The other parts may then be assembled.

It may be necessary to reverse either the primary or secondary connections of transformer *T2* to get negative feedback. Rotation of the controls will have little effect on the tuning if these connections are not properly made.

The cathode resistor *R1* controls the feedback and should be advanced just far enough to provide satisfactory oscillation. The main dial should be rotated to see that oscillation continues at all settings of the controls.

The resistors *R3* and *R6,* and the condensers *C3* to *C8* used in the feedback control circuit, must have close tolerances. The dual potentiometer *R4-R5* must also maintain similar values of resistance at all points of rotation. Other components are not critical as to values.

The transformer *T1* should have a high-impedance primary—the higher the better. The one used in this unit had a 15,000-ohm primary and was found to work much better than other transformers with lower impedance primary windings. The primary winding of *T1* should be connected in the grid circuit of the oscillator tube.

Transformer *T2* is a tube-to-line transformer with a ratio of 2,500- to 500 ohms. The 500-ohm side is connected to the bridge network. A 2,000- to 500-ohm transformer would be better if it can be obtained.

The resistor *R2* is used to insure oscillation at the lower frequencies and may have a somewhat different value for different tubes and transformers.

Panel view of the variable-frequency oscillator, made up from inexpensive spare parts. The center control operates the dual potentiometer R4-R5 which is a part of the bridge circuit.

60-Cycle Calibrator

As stated before, the instrument may be calibrated by using frequency charts and a piano, or by means of a calibrated

oscillator, but care must be taken in the latter case to see that the fundamental is used and not a harmonic. Frequencies above the range of a piano, however, must be obtained by using harmonics.

The calibration can also be done by first finding the 60-cycle point and then using the 60-cycle calibrator to find the other points which will appear every 60 cycles. The 2E5 tube produces an opening or closing pattern when off resonance with the 60-cycle line voltage. Whether it appears to close or open depends on which side of resonance the frequency happens to be. At resonance the pattern is stationary. The harmonics of the oscillator also show up as patterns between 60-cycle points, but the 60-cycle points give a clearer or more vivid pattern and are easily distinguished from the harmonics. At extremely high frequencies the patterns become so close together that it is difficult to see them, but they can be used. Moreover, at the higher frequencies the even harmonics appear as multiple patterns but only show up at the 60-cycle points and therefore will cause no confusion.

The accuracy of the 60-cycle points will vary from a fraction of a cycle at 60 cycles, to 50 cycles at 6,000 cycles. The error is multiplied by the number of the harmonic being used. Thus if the line current is off one-half cycle, the error would be multiplied by 100 at 6,000 cycles. This gives an error of 50 cycles. Most power stations now maintain their frequency within a fraction of a cycle, and some have automatic frequency controls and hold to even closer tolerances.

Audio Amplifier

The audio amplifier operates Class A and is directly coupled to the feedback network to obviate the frequency discrimination of coupling circuits. The excitation should not be great enough to drive the amplifier grid positive, and the cathode bypass condenser *C12* should be 16 μfd. or larger in order to obtain adequate response at the low frequencies.

An output transformer with several different output impedances could be incorporated in the unit in place of the resistance-capacity arrangement shown. An output transformer must be used in any case where the input is to the grid of a tube. For testing and calibrating the input may be direct to a speaker or phones.

In calibrating it is best to couple into a good audio amplifier with dynamic speaker in order to get more nearly true tone at the low frequencies.

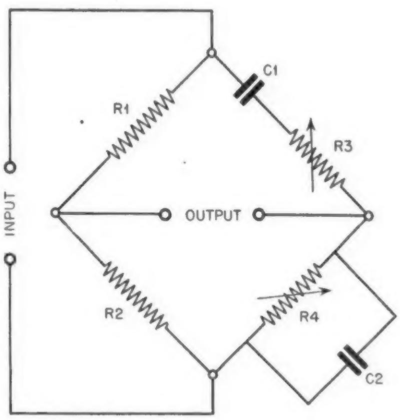


Fig. 1. The basic Wein bridge circuit which forms the frequency determining network in conjunction with various values of fixed capacitance, as shown in the complete circuit below.

Power Supply

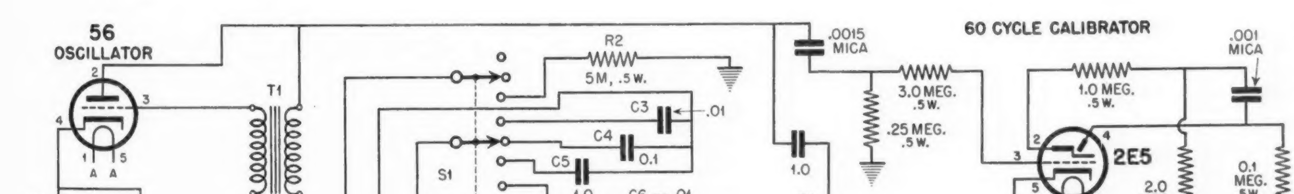
The power supply transformer may be a midget type, with 650-volt center-tapped high-voltage winding. Also it should have a 5 volt winding and a 2.5 volt winding for heater voltages. The 2.5-volt tubes were used because the hum level is less than with 6.3 volt tubes.

The 20,000 ohm resistor *R13* is used to reduce the output voltage to about 150 volts with load. It is not advisable to use much greater voltage than this on the oscillator. More output could be obtained from the audio amplifier by using a voltage divider on the power supply and applying more voltage on the amplifier tube plate. With 150 volts on both tubes the output voltage at no load is about 25 volts. The output varies from 1 to 3 db on the different bands.

Bridge Circuit

The bridge circuit used to control the feedback is the same as that used to measure audio frequencies, as shown in *Fig. 1.* The formula for calculating the values necessary to balance the bridge at a given frequency is expressed thus: When $R1 = 2\ R2$, $R3 = R4$, and $C1$ and $C2$ are equal, $F = \frac{1}{6.28\ R3\ C1}$ in which *R3* is in ohms and *C1* is in farads.

The .1 μfd condenser *C11* is necessary to ground a.c. line to prevent hum when connecting the oscillator to an amplifier without a ground connection. The target and plate of the 2E5 tube are supplied with a.c. voltage from either side of the high-voltage winding of the power transformer. This is necessary to get the calibrating pattern.

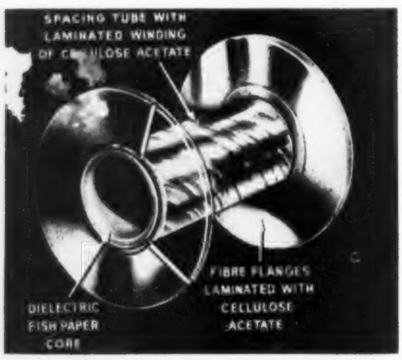


Complete circuit of the variable-frequency audio oscillator with 60-cycle calibrator.

New Products

NEW CELLULOSE ACETATE INSULATED BOBBIN COIL FORM

Much higher corrosion resistance in bobbins for coil windings has been achieved by Precision Paper Tube Company, Chicago, Illinois, by construction in which cellulose acetate is embodied in the bobbins.



Cellulose acetate is used in combination with the spiral-wound dielectric fish-paper core and vulcanized fibre flanges. Spiral wound laminations of cellulose acetate are made over a die to the O.D. of the core and then with a press-fit, slipped over the core to form a spacing tube. The length of the acetate determines the winding area. The inside faces of the fibre flanges are laminated with cellulose acetate before die-cutting, the core then swaged, locking the flanges in place onto the core carrying the spacing tube. Acetate cement is brushed over the joinings to give complete protection and to materially strengthen the bobbin. Fantom view of the new Precision Bobbin indicates this construction.

Uses of this form of coil bobbin are wide; instruments and equipment on aircraft, ordnance, marine services and all uses in which coils are subject to corrosion due to temperature and climatic changes.

Precision Bobbins with the new improvement, are furnished in all forms—round, square, rectangular, and special shapes to fit engineering conditions. The improvement constitutes another addition to Precision's characteristic of light weight, strength, space-saving and super-insulation. It is claimed for Precision that they are the lightest bobbin type coil forms manufactured and that their space saving permits smaller coils with the same gauge of wire and the same number of turns.

Further information will be furnished by Precision Paper Tube Co., 2033 W. Charleston St., Chicago, Ill.

★

"MOTRON" ELECTRONIC CONTROL

The primary purpose of the Motron Electronic Control is to control the direction of rotation of conventional single-phase induction motors by means of electronic control circuits of negligible power, without commutating or interrupting the motor load current, and without the use of mechanical or moving contacts of any type. Thus a directionally sensitive motor of extreme simplicity and reliability is possible.

The Motron system may be applied to any 2-phase or single-phase induction motor of the split-phase centrifugal switch or capacitor types, by minor modifications of the stator windings.

The photo shows the details of the Motron as applied to a G.E. 1/50 h.p. stock motor, to which only minor modifications have been made. The end bells have been ventilated to prevent the motor burning up under continuous reversal of torque the Motron is capable of causing. The Motron and motor operate on 60 cycles 117 volts power, plugging into any light socket.

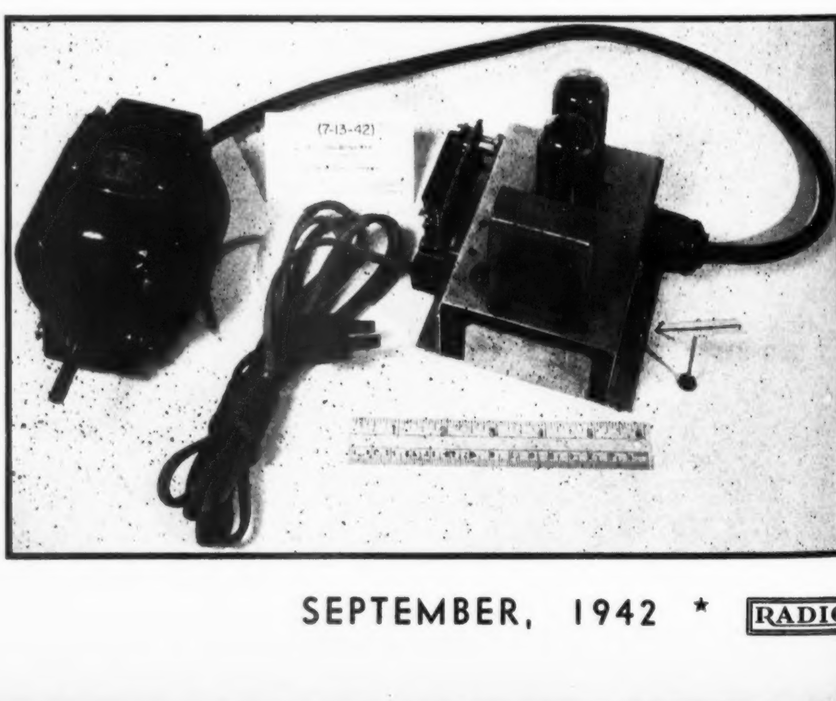
The arrow in the photo points out the two control terminals that control the direction of rotation of the motor. If these two terminals are connected by any circuit of less than 100,000 ohms, or of .001 microfarad, the motor will reverse its direction of rotation from sync speed less slip in one direction to sync speed less slip in the opposite direction. Upon opening the circuit, reversal of rotation to the original direction will again occur. (Touching the two contacts with ones' fingers will usually accomplish reversal.) (The above reversal constants may be extended to 1,000,000 ohms and .0001 microfarad to increase sensitivity, and to any decreased sensitivity desirable but is not ordinarily recommended.)

The control power in this circuit is of the order of 100 microwatts, but the power to make and break this circuit is much smaller, in fact is so small as to be practically unmeasurable. (Catwhiskers probes of .002 diameter and sharp needle points give consistent and reliable control of motor direction over long periods of time.) The model thus has a power amplification of around one million or more.

The torque of the pictured model varies from 2½ to 15 inch-ounces torque at 1700 r.p.m. 1/40 h.p., depending on the type of duty and details of installation.

The weight of the motor is about 5½ lbs. and of the Motron about 2¾ lbs.; i.e., 2:1 weight ratio. The control is about 4"x4"x5" and uses two receiving type vacuum tubes of less than 1 watt rating each.

[*Continued on page* 38]

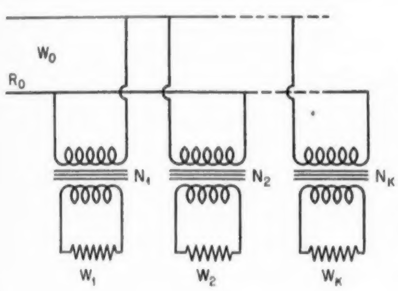


RADIO DESIGN WORKSHEET

NO. 5—PUBLIC ADDRESS

DIFFERING OUTPUT LOADS

Problem 1: *It is sometimes desirable to supply power from an audio amplifier to two or more loads, each at a different impedance and each requiring a different but known power. To accomplish this transformers of the proper ratio may be connected each to its separate load and with their primaries in parallel across the amplifier output. Derive the general expression for the transformer impedance ratio to feed one of a number of loads.*



Solution: First let us take a simple example in which we wish to furnish 8 watts of power to a 15-ohm load, and 4 watts to a 500-ohm load, from a single amplifier. It is well known that if two resistances are placed in parallel across a source of power that the power absorbed by each will be inversely proportional to its resistance. Thus, if one resistance is twice as great as the other it will absorb half as much power. Therefore it follows that the primary which is to absorb 8 watts must present half the impedance to the line as the one which is to absorb 4 watts.

Assume the amplifier output impedance is 500 ohms. Obviously the parallel impedance of the two primaries must equal 500 ohms. The parallel impedance of two impedances is equal to their product divided by their sum.

Let the impedance presented by the primary of the transformer supplying the 15-ohm load be Z_1 and that of the transformer supplying the 500-ohm load be Z_2.

The product $Z_1 \times Z_2 = \frac{Z_2}{2} \times Z_2 = \frac{Z_2^2}{2}$

The sum $Z_1 + Z_2 = \frac{Z_2}{2} + Z_2 = \frac{3}{2} Z_2$

The ratio of product to sum

$$\frac{Z_1 Z_2}{Z_1+Z_2} = \frac{\frac{Z_2^2}{2}}{\frac{3Z_2}{2}} = \frac{Z_2}{3}$$

But $\frac{Z_2}{3}$ must equal 500 ohms

Therefore $Z_2 = 1500$ ohms

Whence $\frac{Z_1}{} = \frac{Z_2}{2} = 750$ ohms

And the impedance ratios of the two transformers will be 1500 to 500 ohms and 750 to 15 ohms.

From this we can easily deduce the ratios of any number of parallel transformers.

Let N represent the ratio of secondary to primary impedance. Designate the load impedances by R_1, R_2, R_k.

It is evident that N_1 varies as $\frac{R_1}{R_0}$

For the case just given this ratio is $\frac{15}{500}$

It is obvious that N_1 also varies in accordance with the ratio of absorbed power to available power. For the case above this is $\frac{8}{12}$ or $\frac{2}{3}$.

It is immediately evident that the product of these two ratios gives the correct value of N_1, that is:

$$N_1 = \frac{15}{500} \times \frac{2}{3} = \frac{30}{1500} = \frac{1}{50}$$

Since the transformer must match its load impedance, we have:

$$N_1 = \frac{15}{50 \times 15} = \frac{15}{750}$$

which checks the solution given above.

If we represent the available watts (15 in this case) by W_0 and the delivered watts by W_1, W_2, etc., the desired relation is:

$$N_1 = \frac{R_1}{R_0} \times \frac{W_1}{W_0}$$

$$N_2 = \frac{R_2}{R_0} \times \frac{W_2}{W_0}$$

$N_k = \frac{R_k}{R_0} \times \frac{W_k}{W_0}$ which is the general expression.

TRANSMISSION-LINE LOSSES

Problem 2: *Estimation of shunt losses in transmission lines. In the layout of sound, public-address, and paging systems, it is frequently necessary to estimate losses due to bridging equipment across the line. While such losses can be readily calculated, the chart of* Fig 1 *will save considerable time.*

Solution: If a piece of apparatus of resistance X is to be bridged across a line of impedance R, the loss may be had by computing the ratio $\frac{X}{R}$ and picking the loss off the curve shown.

Assume resistance $X = 4000$ ohms.

Assume the line impedance $R = 500$ ohms.

Then $\frac{X}{R} = \frac{4000}{500} = 8.$

From the curve of *Fig. 1* we find that impedance ratio 8 corresponds to a loss of 0.5 db Had X been 500 ohms, the loss would have been 3 db.

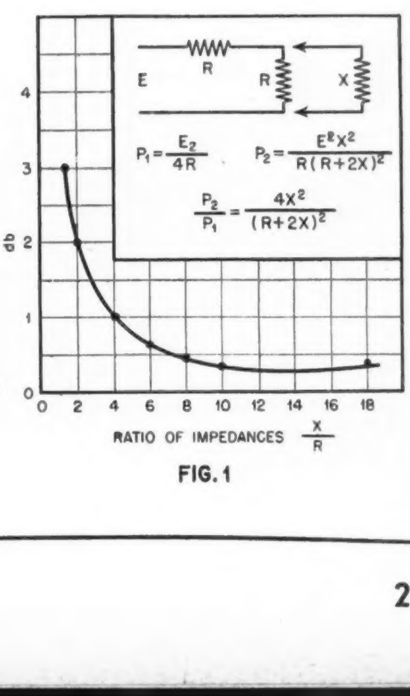


FIG. 1

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RCA Manufacturing Co., Inc.

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First Licenses for Civilian Defense Radios Granted

The first licenses to be granted by the Federal Communications Commission under newly-established regulations for civilian defense radio systems have been issued by the Commission to the City of Akron, Ohio, and the City of Lawrence, Massachusetts. Classified as War Emergency Radio Service these stations extend the organized civilian units functioning under the Office of Civilian Defense. In event of air raids or other enemy action which destroy other forms of communications, the emergency radio will be available to coordinate rescue and repair work.

Under the terms of the licenses granted Akron will have a two-way low-powered radio system of sixteen receiver-transmitters. Some of these will be in fixed locations, others will be mobile and a few will be "walkie-talkies." Lawrence, Massachusetts, has been licensed for a system of eleven two-way radios.

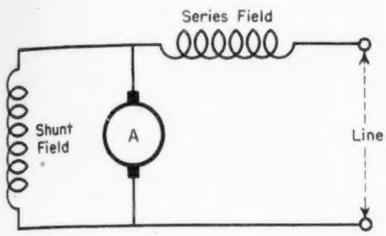
Applications of many other cities are now pending at the FCC and requests from the different communities vary to fit local conditions. Fort Wayne, Ind., has plans for more than one hundred such sets, while Dayton, Ohio, indicates that forty radios will serve its needs. Some applications are being returned to municipalities because the forms fail to indicate what arrangements exist for liaison with Defense Commanders for the purpose of receiving orders of radio silence when conditions dictate. Regulations of the FCC require that the licenses be issued to the municipal governments proper rather than any of the departments.

Formation of the War Emergency Radio Service was announced jointly by the FCC and OCD last June 13 at which time it was explained that radio amateurs, repairmen and others having sufficient experience would be asked to volunteer and serve in the operation of the civil defense radio systems. The two-way radios operate on ultra-shortwaves with power sufficiently low to limit their range to approximately ten miles. Spare parts laying around radio repair shops are considered sufficient to construct these radios.

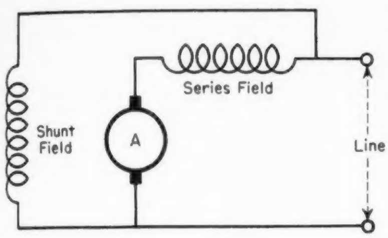
Q & A Study Guide

[*Continued from Page* 16]

has both a shunt and series field, and combines the attributes of both these motors to a somewhat limited extent. The torque is greater than that of the shunt motor, but slightly less than the series, and the variations of speed relative to load are likewise. The compound motor is most practical where the load



(A) SHORT SHUNT



(B) LONG SHUNT

COMPOUNDED D.C. MOTORS

FIG. 5

is of wide variation, as a strong torque is rendered to start and drive heavy loads, yet the motor will not "run away" if the load is suddenly removed. Resistance in the armature circuit will reduce speed; shunting the series winding, or inserting resistance in the shunt winding, will increase speed.

223. What is the output frequency of a generator having 10 poles and revolving at 1200 r.p.m.

Using the formula given in the answer to Question 220:

$$f = \frac{PS}{60} = \frac{10 \times 1200}{60} = 200 \text{ c.p.s.}$$

224. How may the direction of a shunt-wound d.c. motor be reversed?

Reverse the direction of the armature current or the magnetic field. (Do not reverse both armature and field, or no reversal in direction will be attained.)

225. Why are series motors not used for motor-generator sets?

Constant speed is required regardless of load. The series circuit varies in speed as the load is varied.

226. Why is carbon commonly used as a brush material?

To facilitate sparkless collection. The high resistance of the carbon brush limits the current which may flow in the

armature coils as the latter are short-circuited by the brushes.

227. If a self-excited d.c. generator failed to build up to normal output voltage when running at normal speed, what might be the cause and how could it be remedied?

The resistance of the field circuit is probably too high. Decrease the resistance to a minimum, and then when the voltage builds up, readjust the resistance for the normal output value. (Increasing the speed will also increase the voltage. If normal speed is attained, however, the speed should not be increased any further.)

Coil Winding

[*Continued from Page* 21]

candle-power sources scattered on the ceiling, with a goose-neck lamp on the bench to boost local illumination. The average ceiling system not only gives insufficient illumination, but also produces glare that causes eye strain. As far as the goose-neck lamp is concerned, it may give the desired intensity, but the contrast between its brightness and that of the surrounding area is too great for the eye to readjust itself when looking away from the work and back again.

What is considered as satisfactory lighting for winding fine wires is a uniform illumination of at least 25 foot-candles over the whole working area and its vicinity. Glare should be eliminated by utilizing auxiliary light-diffusing equipment.

BC Station Operation

[*Continued from Page* 13]

9. Once per shift, check and *log* all temperatures on proper form.
10. Every two hours, *log* all Transmitter meter readings on proper form.
11. Immediately following sign-off, *log* final set of all Transmitter meter readings.
12. Remove plate voltage, bias and drive.
13. Slowly decrease P.A. filament voltage from normal to minimum, over 2-minute period.
14. Push Stop button.
15. Check all 46th floor items for normalcy.
16. As soon as possible, check all component parts of I.P.A., 3-kw Driver, and 50-kw Stage for undue temperature rises, etc.
17. After final shut-down of coolers, return to 46th floor and close shutters in both air ducts (manually), and ground plate transformer.

18. Ground Driver and 50-kw Stage tanks and transmission lines.
19. Investigate all discrepancies reported during the day.
20. Check all spacings and clearances of component parts of 50-kw Stage.
21. Dust and clean all transmitting equipment, except on Saturdays and Sundays.
22. Watch contacts on power breaker, but *do not* dress down unless absolutely necessary.
23. Check blower motors in P.A. room, Driver room, and Rectifier-Power Control room.
24. Clean work bench and shop.
25. Total and *log* program time for shift and day on back of Transmitter Log.
26. Enter all discrepancies on Transmitter Log.
27. Enter all maintenance work in Work Report Book.
28. Leave note for morning men, reporting any and all unusual items that occurred on your shift.
29. Be sure that all windows and doors are locked, *and lights turned out,* before leaving.

(To be continued)

Book Review

[*Continued from Page* 19]

III includes information on certain tubes closely allied to receiving tubes but customarily tabulated separately and identified as "special purpose." These tubes are particularly of interest for applications involving special performance requirements. Socket connections are shown on pages 13, 14 and 16, with RMA designations where assigned (4AD, 4B, 4C, etc.).

The 72-page, 1942 RCA Guide for Transmitting Tubes retains the same general appearance as the 1941 edition but it has been completely revised and much new material has been added. New information includes a Special Reference Chart cataloging air-cooled and water-cooled transmitting tubes, transmitting and television rectifiers, cathode-ray tubes, phototubes, voltage-regulator tubes, and special purpose tubes.

As in the previous edition, the 1942 RCA Guide contains three major sections, as follows:

(1) *Transmitting-Tube Data:* This 37-page section gives pertinent data, basic circuits, and socket connections for popular power tubes. Also included are gas-triodes, gas-tetrodes, and the u-h-f acorn and midget types. Supplementing these data, 5 pages are devoted to the Special Reference Chart.

(2) *Transmitting-Circuit Facts:* This section includes 6 pages of helpful information on the design, adjustment and operation of transmitters.

(3) *Transmitter Construction:* In this 20-page section, the layout, adjustment and operation of equipment is illustrated by descriptions of several rigs. These descriptions will be of help to all those engaged today in the design of similar equipment to meet specific requirements.

Readers in the United States can obtain a copy of 1942 RCA Guide for Transmitting Tubes from their nearest RCA distributor or by sending 35 cents to Commercial Engineering Section, RCA Manufacturing Company, Inc., Harrison, N. J. From the latter source, readers may obtain a copy of RCA Receiving Tubes and Allied Special-Purpose Types on request.

★

CHANGE TUBE DIVISION NAME

The Vacuum Tube Division of the General Electric Radio, Television and Electronics Department will henceforth be known as the Electronic Tube Division, according to a recent announcement by Dr. W. R. G. Baker, Vice President in charge of the Department.

New Products

[*Continued from Page* 24]

The maximum horsepower motor this size Motron is capable of directing is in general directly proportional to the supply frequency, if the effects of windage, hysteresis and eddy current losses are neglected. This is because the torque of an induction motor is proportional to load current and speed is proportional to frequency. Therefore to a first approximation, on 400-cycle current, 6 to 7 times the horsepower of 60 cycles supply should be obtained, if suitable design constants are used. The 2¾ lb. Control should direct a 1/6 maximum h.p. motor on 400 cycles.

For further details, address W. C. Robinette, 804 No. Chester, Pasadena, Calif.

★

JENSEN ANTI-CORROSION HYPEX PROJECTORS

Series 201 Hypex Projectors are for the reinforcement of speech or other audio sound at relatively high levels and over wide areas. Compared with conventional or standard commercial products of this kind, these designs are distinguished by strong mechanical construction and ability to withstand the corrosive and other deteriorating effects of continued exposure to salt-laden atmosphere, highly humid climates and other severe weather conditions.

Voice-coil impedance is 16 ohms nominal value. Nominal low-frequency cutoff is 160 cycles, high-frequency cutoff approximately 5000 cycles, with a maximum of ± 5 db variation in range from 200 to 5500 cycles.

Measured pressure output is 32.7 bars (104 db) at distance of ten feet from mouth of horn when measured in free space with one watt input, 700-1300 cycle warble frequency. Total radiation angle is 54° (700-1300 warble), with maximum loss of 3 db throughout total angle.

Power handling capacity is 20 watts minimum when 700-1300 warble is continuously applied for 100 hours. This accelerated life test insures 25-watt peak power-handling capacity in conventional use.

For further details, address Jensen Radio Mfg. Co., 6601 So. Laramie Ave., Chicago.

★

LOW-RADIATION RECEIVER

The elimination of one direct cause of American ship losses was made possible recently by the introduction of a new *low-radiation* radio receiver by the E. H. Scott Radio Laboratories, Inc., Chicago, Illinois. Unlike ordinary radios (large or small) this specially designed set gives off no signal detectable by enemy direction finders, and it thus foils subs and ships which have heretofore been able to track down our boats from distances of 100 miles or more away simply by listening to the constant oscillator radiations sent out by the entertainment radios aboard them.

The new Scott Marine Model SLR-12-A eliminates this danger to shipping by cutting oscillator radiation to

the point of absolute safety. It has full approval from the F.C.C. for use at sea on both broadcast and shortwave bands, assuring for the first time excellent performance at greatest distances from land under difficult shipboard conditions.

Many shipping authorities are convinced that this low-radiation receiver offers the solution to a number of today's tough shipping problems, not only because it is safe and protects men, ships and materials, but because it lessens hiring difficulties and greatly boosts shipboard morale. For full details about this marine receiver, write to E. H. Scott Radio Laboratories, Inc., 4450 Ravenswood Avenue, Chicago, Illinois.

★

NEW CLAROSTAT STABILIZED ELEMENT CONTROLS

Important developments in the processing of resistive coatings have resulted in potentiometers and rheostats claimed to be virtually on a par with wire-wound units in matters of resistance permanence, immunity to climatic conditions and wearing qualities.

Clarostat Series 37 controls employ the new stabilized element that takes the form of a resistive coating on a bakelite base, being practically as smooth and hard as glass. The element is chemically treated during processing to eliminate all further changes in its composition. It is likewise heat treated to stabilize its temperature and humidity characteristics.

Controls incorporating the new stabilized element were quietly introduced to the trade many months ago, so as to get the reaction of users out in the field. Users have been prompt to spot the new element. Accurate resistance values first and last, even after months of continuous usage under adverse conditions, have been noted. Likewise noted were the accuracy of tapers, taps, and hop-offs. So much so that leading instrument makers are now using these controls in place of former wire-wound units even for relatively low resistance values. Series 37 controls with the new stabilized elements are made by Clarostat Mfg. Co., Inc., 285-7 N. 6th St., Brooklyn, N.Y.

UNIVERSAL MIKE SWITCH

Universal Microphone Co., Inglewood, Cal., has announced the distribution of standard microphone switch SW-141, available in quantity orders to government contractors and sub-contractors. The assembly is housed in plain plastic case with hanging eye at the top.

SW-141 switch is complete with cable strain relief construction. The switch may be used as a press-to-talk type, or the locking button may be used on the "on" position.

Lightweight, compact, durable, SW-141 switch can be adapted for various

communications devices for mobile units. It was specifically designed and engineered for use on cord assembly CD 318, as well as cord CD 508, but also has other applications. It has been built to specifications of the Army Signal Corps and approved by that office.

COMPENSATION AND EMPLOYMENT IN BROADCASTING SHOWS 1941 INCREASE

Personnel increases and advances in average salaries in the radio broadcasting industry again were reflected in annual financial reports of stations and networks which are filed with the Federal Communications Commission. Using the week beginning October 12, 1941, as a base period, three national networks, five regional chains and 817 standard broadcast stations reported that 23,666 persons were employed on a full time basis having a weekly payroll of $1,138,249. This showed a personnel increase of 2,020 people for the industry, and a growth of the weekly salary total by $121,883 over a similar period in 1940.

Exclusive of executive personnel the average weekly wage at the national radio chains was $57.41, representing a dip of fourteen cents from the year before, while the $48.39 average at regional networks represented a $6.81 climb, and individual station increases of $1.13 brought average pay envelopes to $38.88. Staff musicians and artists employed full time are included in the totals but those persons hired by radio departments of advertising agencies or program sponsors are not. The eight broadcasting systems had 4,009 full-time workers and the remaining employees were on the rolls of individual stations. FCC accountants after studying earlier reports stated that 1941 returns show the consistent growth of employment and average compensation within the broadcasting business.

The average weekly compensation for the 19,567 full-time employees of the 817 stations was $45.15, an increase of $1.64 over 1940. Of these full-time employees 2,426 were in the executive class with an average weekly pay of $89.46, an increase of $5.04 over 1940, while the remaining 17,141 below the grade of executive had an average weekly income of $38.88, an increase of $1.13 over 1940. For the major network executives the average was $258.83 as compared with $251.68 for 1940, while the major network employees below the grade of executive was $57.41, a decrease of 14 cents from 1940. It is noted that the employees of the regional networks had a more encouraging experience with the executive class, advancing from an average weekly pay of $91.50 in 1940 to $137.57 in 1941 while those below the grade of executive were having an increase in pay from $41.58 in 1940 to $48.39 in 1941.

★

NEW 100-KILOWATT TRANSMITTER FOR WGEO

A new 100-kilowatt radio transmitter has completed extensive tests and is now operating full power for WGEO, one of the two General Electric international broadcasting stations in Schenectady, it was announced Aug. 13 by Robert S. Peare, G-E broadcasting manager.

The transmitter replaces one of equal power released at government request last December to KWID, San Francisco, to augment the programs of KGEI, General Electric station there, and to increase California short-wave facilities to combat Japanese propaganda in the Pacific.

During construction of the new transmitter, WGEO continued on the air without loss of time by the use of a previously licensed 25-kilowatt transmitter.

★

HALLICRAFTERS AWARDED ARMY AND NAVY "E" CITATION

The Hallicrafters Company have been notified by Under Secretary of War Robert P. Patterson that they have been awarded the Army and Navy "E" Banner, according to an announcement by W. J. Halligan, President of Hallicrafters.

The Company was complimented in Mr. Patterson's notification letter for the "high achievement attained in the production of war equipment.

"The high and practical patriotism of the men and women of The Hallicrafters Company is inspiring. Their record will be difficult to surpass, yet the Army and Navy have confidence that it was made only to be broken."

Formal presentation of the "E" Banner was made Wednesday, September 9th, at the Hallicrafters Main plant where Army and Navy officers made the award. Chicago civic leaders and State officials were present.

★

F. R. TUERK NEW UTAH PRESIDENT

Effective September 1, 1942, Mr. Fred R. Tuerk becomes President of Utah Radio Products Company. Mr. G. Hamilton Beasley, President for the last five years, has been elected Chairman of the Board.

Mr. Beasley is also President of The Caswell-Runyan Company of Huntington, Indiana (wholly owned subsidiary of Utah Radio Products Company). Due to the serious illness of Mr. J. W. Caswell, Mr. Beasley will devote a greater portion of his time to the Caswell-Runyan Company.

He will continue to take an active

part in the management of Utah, whose entire production facilities are and have been for some time past concentrated on war products.

Outside of the above change, the Utah executive roster remains as it has been for many years: Henry S. Neyman, Vice President and Treasurer; W. Dumke, Vice President and Secretary; W. A. Ellmore, Chief Engineer, and O. F. Jester, General Sales Manager.

★

WALL CHART OFFERED BY ELASTIC STOP NUT

A wall chart, explaining the uses of its various types of self-locking nuts, is being distributed by Elastic Stop Nut Corporation, Union, New Jersey, to engineering departments, drafting rooms, maintenance shops and schools.

The center of the chart is devoted to an illustrated description of the basic principle by which a self-locking action is obtained in all Elastic Stop Nuts. This is followed by illustrations of some of the advantages to be obtained by the use of the nuts and, completing the presentation, there are cross-section drawings showing the method of application of the nine types most generally used, with corresponding photographs of these types.

The chart measures 21 by 27 inches and is reinforced at top and bottom by metal strips, with an eyelet for hanging. Copies can be obtained by writing to the manufacturer.

★

CORRECTION

In the schematic diagram of "The Transitron Audio Oscillator," shown on page 19 of the August 1942 issue, the connections of the control grid and the suppressor grid of the 6J7 should be reversed, with the suppressor connecting to the arm of potentiometer *R2* and the control grid connected to the cathode.

★

FARNSWORTH PROMOTES KELSO

Mr. Glen E. Kelso has been appointed superintendent of manufacturing for the Fort Wayne plant of the Farnsworth Television & Radio Corporation according to an announcement by Mr. R. C. Jenkins, general superintendent of Farnsworth plants.

Mr. Kelso is well qualified by experience to fill his new position inasmuch as he has been acting in an executive capacity in the manufacturing division of the company since its inception and had served with the predecessor organization in various supervisory capacities since 1929.

★

ISSUANCE OF AMATEUR STATION LICENSES DISCONTINUED

The Commission by its Order No. 87-B adopted September 15th, has discontinued the issuance of new, renewal, or modified amateur station licenses until further order of the Commission. This action has been taken in view of the many difficult administrative problems which have arisen in connection with the issuance of amateur station licenses as a result of the war. Inasmuch as many licensees are in the military services or engaged in war industries in various parts of the country, it is impossible for such station licensees to exercise proper control of transmitting apparatus and the control of the premises upon which such apparatus is located as required by the Rules and Regulations Governing Amateur Radio Stations and Operators.

Commission Orders No. 87 and 87-A adopted December 8, 1941 and January 8, 1942, respectively, require complete cessation of all amateur radio operation in the interest of national security. The Commission, however, continued to renew and modify existing amateur station licenses in view of possible utilization of such stations in connection with Civilian Defense activities. The establishment of the War Emergency Radio Service, however, will provide Civilian Defense and State Guard organizations with the desired emergency communication in connection with the national defense and security. The Commission will continue its policy in regard to the issuance of new or renewed amateur operator licenses or modification of such licenses for change in operator privileges. The holder of an amateur operator license desiring to maintain his amateur status should submit application for amateur operator and amateur station license renewal in accordance with the Rules.

With respect to amateur station licenses which are valid as of the date of adoption of Order No. 87-B and are not revoked prior to their expiration, it is contemplated that the licensees thereof, who maintain valid amateur operator licenses, will be granted appropriate amateur station authorization when amateur stations are again allowed to be operated, subject to the filing of such additional application(s) as may be required. It is further contemplated that the future operation of amateur stations will be authorized upon such bands of frequencies as may then be allocated to the amateur service.

Insofar as it is possible and practicable to do so, the call letters of outstanding amateur station licenses will be reserved for assignment to the present station licensee upon proper application when licensing of amateur stations is resumed.

★

RAULAND ACQUIRES AMERICAN RIGHTS TO BRITISH TELEVISION PATENTS

Mr. E. N. Rauland, president of the Rauland Corporation of Chicago, announces a significant expansion of the activities of that company, through the acquisition of title to the American patents of the Gaumont-British Picture Company of America, Cinema-Television, Ltd., and Baird Television.

An interview with Mr. C. P. Cushway, vice-president of the Rauland Corporation, reveals that Rauland has acquired all of the American interests and the exclusive rights not only to all existing patents of these companies for the Western Hemisphere, but the rights to patents on all future developments of the Gaumont-British Picture Corp., Ltd., of London, England, in the fields of Television, Electronic tube developments, and other light-sensitive devices.

The acquisition of these patents and interests will result largely in activities in the design and manufacture of equipment for Television transmission and reception, with emphasis on theatre installations (in which there has been considerable progress in Great Britain). Further, the patents are concerned also with sound transmission and reception for use with radio and television. Facsimile and photo-telegraphy transmission and reception are additional fields in which activities are planned. Military and industrial application of light-sensitive devices are an important aspect of the patent acquisition, particularly as the Rauland Corporation is engaged almost exclusively in war production.

The Rauland Corporation has also taken over in its entirety the laboratory and engineering staff as well as the equipment of Cinema-Television, Baird Television and the Gaumont-British Corporation of America. This covers all of the United States interests of the parent Gaumont-British Company, Ltd., of London, England.

Headed by Dr. C. S. Szegho, Chief Research Physicist, a leading European figure in electronic research, the new personnel has been added to the present laboratory and engineering staff of the Rauland Corporation, and plans for the expansion of electronic engineering activities are already under way.

★

JOLLIFFE APPOINTED VICE PRESIDENT AND CHIEF ENGINEER OF RCA

Dr. Charles Byron Jolliffe, Assistant to the President of the Radio Corporation of America, and Chief Engineer of RCA Laboratories, has been appointed Vice President and Chief Engineer of RCA Manufacturing Company, Camden, N.J., according to a joint announcement made today by G. K. Throckmorton, Chairman of the Execu-

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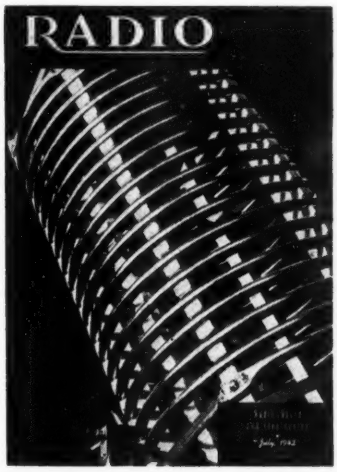
Announcement—

This is the last issue of "RADIO" to be sold on a newsstand

"RADIO"—The only magazine devoted *exclusively* to radio research, design, production and operation.



"RADIO" is edited for engineers, designers, technicians, production men, and operations personnel.

Effective with the October, 1942, issue "RADIO" will be available only on an annual subscription basis—$3.00 for 1 year, $5.00 for 2 years.

SPECIAL SUBSCRIPTION OFFER FOR A LIMITED TIME

15 Big Issues - $3.00 regular price is $3.00 for 12 issues

27 Big Issues - $5.00 regular price is $5.00 for 24 issues

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tive Committee and Robert Shannon, President of RCAM.

Dr. Jolliffe, born November 13, 1894, at Mannington, West Va., was graduated from West Virginia University with a B.Sc. degree in 1915, and achieved the M.S. degree at West Virginia in 1920, and the honorary degree LL.D. from his Alma Mater in 1942. He was awarded the Ph.D. in 1922 at Cornell University where he was instructor of physics from 1920 to 1922. From 1922 to 1930 he served as a physicist in the radio section of the Bureau of Standards, and left that post in 1930 to accept the appointment of Chief Engineer of the Federal Radio Commission, the position he also held under the Federal Communications Commission in 1934.

★

ARMY-NAVY "E" AWARD TO CROWLEY

That the war must be won on the production line before it can possibly be won on the fighting front, was the keynote of the colorful ceremonies marking the presentation of the Army-Navy "E" for production excellence to Henry L. Crowley & Company, Inc. on Friday, September 4th.

Aircraft Detection

[*Continued from Page* 15]

miles apart connected by a straight line, *A* to *B*. If at 7:00 p.m. the plane crosses point *A* and is traveling at the rate of 240 miles/hour, it will reach point *B* at 7:03 p.m. If the sound is heard at the time the plane crosses point *A*, the sound will travel at the rate of 12 miles per minute and will arrive at point *B* at 7:01 p.m., or two minutes ahead of the plane.

Counting mentally from 0 to 250 will give you some idea of what can be accomplished in 2 minutes, but would not be of much help in an air alarm system. On this basis alone, civilian aircraft detection by audio systems is impractical and wasteful of time, effort and money, not to mention the danger of a false sense of security.

A far better system is to rely on nothing more fancy than a pair of good ears, possessed by spotters located some distance away from the spot to be guarded; in other words, men situated 50 or 100 miles away from the place that is in danger of being bombed. It would take a plane traveling at 240 miles/hour fully 12.5 minutes to travel 50 miles and 25 minutes to traverse a 100-mile route. A practical air-raid system of warning using these time intervals is valuable and sensible.

Science of Sound

A great deal has been written on the science of sound. The most important basic and fundamental work of all seems to have been performed by Lord Ray-

[*Continued on page* 47]

M. L. MUHLEMAN
LEE ROBINSON
S. R. COWAN

RADIO

ESTABLISHED 1917

EXCLUSIVELY DEVOTED TO RADIO RESEARCH, DESIGN, PRODUCTION AND OPERATION

RADIO MAGAZINES, INC.

132 WEST 43rd STREET, NEW YORK, N. Y.

CHickering 4—3278-9

September 23, 1942.

To The Radio Industry!

Gentlemen:

"RADIO"--the radio industry's oldest publication, (established 1917) is now owned and published by Radio Magazines, Inc.

The Corporate and publishing personnel of Radio Magazines, Inc., comprises Lee Robinson, President & Publisher; M. L. (Bud) Muhleman, Vice-President & Editor; S. R. (Sandy) Cowan, Treasurer & Business Manager, who are the sole stockholders. The new Corporation will work in close cooperation with the Cowan Publishing Corp., which continues to publish "Radio Service-Dealer' as heretofore.

Executive, editorial and advertising offices of Radio Magazines, Inc., are located at 132 W. 43rd Street, New York City, to which address all correspondence, advertising copy and cuts should be directed hereafter.

Editorially "RADIO" will continue in its present pattern as a "vertical" monthly publication covering exclusively all phases of radio research, design, production and operation. The Radio Industry has long needed such a publication. "RADIO" will cover present-day radio progress and engineering developments with an eye to the vitally important post-war period sure to follow.

In circulation "RADIO" now broadens its scope. Henceforth no copies will be sold on newsstands. Instead, every month the radio industry's 12,000 foremost engineers, designers, consultants, technicians in the armed forces and manufacturers--all carefully selected "key men"--will receive their copy of "RADIO" through the mails. Many of these men are already paid subscribers. "RADIO" will select and control its paid circulation to avoid penalizing advertisers with waste or non-buying power distribution.

The radio industry is slightly over 20 years old, yet it is but in its infancy. Each of the officers of Radio Magazines, Inc., has been closely associated with the radio industry since its inception. Thus our aggregate 60 years of practical radio experience give "RADIO" a solid foundation upon which we plan to render a definite service in your behalf. Thank you.

Yours very truly,

"RADIO"

Lee Robinson

Publisher.

Lee Robinson:cc

leigh, an English scientist, and his book, "Theory of Sound" is a classic. Others from time to time have elaborated on his principles and have given simplified explanations. A thesis at Columbia for the Ph.D. degree, by P. Mason, gives data of a mathematical nature on sound propagation in tubes, and their possibilities as acoustic filters are discussed. An important work, almost on a par with Rayleigh's, is "Dynamical Theory of Sound," by Lamb. This book is highly mathematical and gives data on the Fourier series, simple harmonic motion, strings, wave equations and many other sections of sound theory. Crandall, in "Theory of Vibrating Systems," discusses exponential horns. A horn has the facility of matching the high pressure, low velocity characteristic at the mouth to the low pressure, high velocity feature at the opening. It serves chiefly as an acoustic impedance-matching device, transferring the low impedance at the mouth to the comparatively high impedance at the opening area. Of course, what works one way also works in the opposite direction, and such a horn, whether exponential or conical, also works to pick up sound and aid in hearing. Grandmother's ear trumpet and familiar, "Eh?" are recalled. Another simple system is that of merely cupping your hand to your ear and listening. In any horn, however, a roar will be produced similar to the sound of a sea shell. This destroys the purpose of the device and you can hear just as far without as you can with it. The same thing applies to a microphone and amplifier, only even more so. The mike will pick up the slightest sound, and noise along with the desired sound will be reproduced so that it is extremely difficult to pick up what you want. Unless you have a tin ear, the mike won't be much help. Another point is that the mike is not two-eared or binaural and thus does not distinguish direction. Your skull is interposed between your ears and if you are facing north and a sound comes from the west, your left ear will hear it before your right ear does, because the sound must travel the additional distance around the head to reach the other ear, giving a differential effect in terms of both amplitude and phase. As the ear seems to integrate phase differences, it appears that the difference in amplitude is the most important factor.

Sound Propagation

Concerning the propagation of sound through tubes, Eckhardt, in Technological Papers, Bureau of Standards, Government Printing Office, gives data on calculation of attenuation. A formula for it is:

$$a = \frac{2.303}{L} \log_{10} \frac{I_o}{I}$$

where a = attenuation constant, I_o = output intensity of sound and I = starting intensity at entrance to tube. If a is known,

$$\log_{10} \frac{I_o}{I} = 0.4343\ A\ L$$

and the attenuation for any length can be predicated. For a ratio of input to output of .0001, you can have a 2-inch brass tube 307 feet long, if you want it.

In this paper, also a curve is given showing that speech energy is distributed in such manner that 80% of the area is occupied by frequencies lying below 1,000 cycles. It is significant, in this connection, that signals below 1,000 cycles are not affected to any great extent by fog, but higher frequency signals are attenuated severely, the attenuation increasing as the frequency is raised. In "Researches on Sound", by Joseph Henry, experimental data on fog horn investigations is given. Mathematics are not used. The effects of wind and elevation are described. It is mentioned that fog, snow and rain have little effect on the low-frequency fog horn tones. Sound is refracted or bent upwards, according to his observations, by wind. For this reason, if sound is traveling towards an observer and the wind is against the sound, the wavefront of the sound may have an uneven velocity, causing it to curl upwards and possibly escape being heard. The same refraction may also take place where the medium, air, has an uneven density due to temperature. These vagaries of sound point up the difficulty of getting accurate position by dependence on sound, and Henry points out, for example, that at the battle of Seven Pines, in June, 1862, near Richmond, General Johnston of the Confederate Army was within three miles of a battle scene where guns roared for over two hours and he did not hear them. Not a single gun was heard.

An explanation of how sound can be refracted by layers of air being at unequal temperatures has been given by Prof. James Thomson. With R as radius of curvature, and the two wavefronts pass through the extremities of an element δS_n of the path, are inclined at an angle, δ S/R and $\delta S'$ is an adjacent ray in the same vertical plane. Then,

$$\delta S' = \left(1 - \frac{\delta n}{R}\right) \delta S$$

where δ Sn is the distance between the two rays.

"Sound," by F. R. Watson, published by John Wiley, 1935, is a modern, practical treatise on the subject and involves only algebra and trigonometry. It is not "easy" as a text for the student, however, and those with mental laziness might just as well avoid it. Amongst other things of interest to radiomen, it describes sound ranging. A sketch is drawn showing how the position of an unknown gun is determined. Sound from a source proceeds in spherical waves, and a wavefront is formed. Three observation stations A, B, and C receive the signals, the sound being recorded on a rotating drum, electrically connected to the three points. The station A, closest to the source, gets the sound first, then B and C follow. The time of A is $t = O$, $B = tl$ and $C = t2$. To locate the source, draw a circle about B with a radius vtl, where v is the velocity of the sound, and a second circle around C, with its radius equal to $vt2$. The wavefront is tangent to the two circles and passes through A. This book also gives a simple version of Snell's Law of refraction: $\sin i / \sin r = \mu$, where μ represents the index of refraction.

Doppler's Principle

It is of some interest to see the practical application of Doppler's Principle, which states that a source moving toward an observer causes a decreasing frequency of sound to be heard, with the opposite effect if the source moves away from the observer. In other words, as a plane comes closer, the pitch of the motor sounds lower, and as it moves away the pitch goes higher and finally goes into the supersonic range. If the source is 500 cycles and moves 10 ft./sec. towards an observer, and wind in the same direction is moving at 5 ft./second, and sound velocity v is 1120 ft./sec., the resultant wavelength is:

$$\lambda = \frac{(1120 + 5 - 10)}{500} = 2.23 \text{ feet}$$

If the observer is at rest, he gets:

$$f = \frac{(1120 + 5)}{2.23} = 504.48 \text{ cycles}$$

Should he move toward the source at the rate of 10 ft./sec., he gets $\frac{10}{2.23}$ cycles or 4.48, giving a total of 508.96 cycles per second:

$$f = 500 \; \frac{1120 + 5 + 10}{1120 + 5 - 10}$$
$$= 508.96 \text{ cycles}$$

Also, in this book, by Watson, a formula is given which originally was derived by Rayleigh in "Theory of Sound," for the purpose of determining approximately the frequency of a tuning fork made of steel. It is:

$$f = \frac{84{,}590\ t}{L} \text{ cycles}$$

where t = thickness of each prong
L = length of each prong

Supersonics

An excellent book on supersonics, sometimes referred to as ultrasonics, is that written by L. Bergman, published by G. Bell & Sons, Ltd., London, 1938. It is called "Ultra-Sonics." It discusses very completely the principles of ultrasonic generation by means of quartz crystals and magnetostrictive oscillator arrangements, amongst other things, and the reactions of chemical substances to such waves beyond audibility. In "Sound Waves, Their Shape & Speed", D. C. Miller, published by Macmillan, 1937, the velocity and propagation of sound is brought out and the use of and details concerning the phondeik are brought to attention. Miller gives the Newton-Laplace formula for the sound velocity in air as:

$$V_0 = \sqrt{\frac{\chi p}{d}}\ \phi$$

where V_0 = velocity of sound
χ = ratio of specific heat at constant pressure to the specific heat at constant volume
d = air density
ϕ = is a correction factor, since air is not a perfect gas
p = is the atmospheric pressure in dynes per sq.cm.

The density of sea air, presuming the normal content of 3 parts CO_2 in 10,000 by volume is $d = 0.0012929$ grams per cu.cm. The pressure of the air at Sandy Hook, where the observations were

BONDS BUY BOMBS

Advertising Index

made was $p = 76\ \delta g$ where δ is the density of mercury and g is the acceleration due to gravity. The value of δ is 13.5951 grams per cu.cm., the calculation being made for dry air at 0 degrees Centigrade under 76 cm. mercury pressure. Then, $g = 980.212$, $\chi = 1.4029$, $\phi = 0.998930$ and $V_0 = 331.36$ meters per second at 0° C.

He gives other interesting facts; for example, thunder is seldom heard at a distance of greater than ten miles, although when Krakatoa, a volcano lying off Java and Sumatra blew up in August 1833, the sound was heard 3,000 miles away and traveled several times around the earth, being recorded on instruments. This shows that the range is proportional, amongst other things, to the intensity of the disturbance. The velocity of the wave is,

$$V = \sqrt{\frac{e}{d}}$$

Where V = velocity
e = elasticity of medium through which wave passes
d = density of medium

From this we can see that increasing the density will decrease the sound velocity, and if we put a thick wall between a source of sound and an observer, the sound is cut down in velocity and takes longer to get through. The velocity of sound, in a steel rod is 5,000 meters/sec. or 16,410 ft./sec., and in water at 13°C. it is 1,437 meters/sec. or 4,715 ft./sec.

The intensity of sound, energy of motion, is measured by the energy that is transmitted through 1 sq. cm. of surface. The energy per cu. cm. in a sound wave depends on the density of the medium d, the square of the frequency of vibration n^2, the square of the amplitude a^2, and it is expressed by the formula:

$$e = 2\pi^2 d n^2 a^2$$

It has been found by Rayleigh that when the amplitude of vibration of the air particles is as small as 1/1,000,000 millimeter, the sound is barely audible. An amplitude as great as 1 mm. would occur only in the very loudest sounds. The intensity will vary inversely as the square of the distance between source and observer. The interpretation of these formulas, however, must take into consideration other facts. For example in the above formula, one term, n^2, would make it appear that as the frequency is increased the wave would be more intense. This does not take into account the attenuation above 1,000 cycles of sound in fog, for example, and it is such things as this which you must be on the alert to catch when dealing with any formula.